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The Schoolhouse—Its Heating and Ventilation

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JANITORS

VIII [Conclusion]

(This Series of Articles Commenced in Our April, 1906, Number)

Success or failure in obtaining satisfactory results with a well-designed system of heating and ventilation often depends upon the care and good judgment exercised by the janitor or engineer having charge of the apparatus.

Complaints have frequently been made that the heating and ventilation of a school building were not satisfactory; that the rooms were too warm or too cold; that uncomfortable drafts were felt; that the air was bad, etc. On inspection, these complaints were often well founded, and on looking for the cause it was very frequently discovered to be the fault of the engineer or janitor in charge, and not of the apparatus installed in the building.

A janitor or engineer who is negligent, or not informed as to the proper way of operating the apparatus under his control, can easily give a well-designed and a properly installed system a bad name.

If heating and ventilating engineers and contractors who install systems in schools and public buildings will see that the engineer or janitor is properly instructed as to his duties when first taking charge, they will find it greatly to their advantage; not only as to the reputation their work will have, but they may be saved expense in responding to calls to come and see what is the matter with the apparatus.

Printed instructions provided by the contractor or engineer who designed the work, if posted in the boiler or furnace room, will more than pay the expense of printing and posting, and will save annoyance.

A janitor who understands the system and properly manages it will not only give better satisfaction to the school authorities, but will in many cases make a considerable saving in the expense of operation.

An incompetent or lazy janitor may cause an excessive waste of fuel and perhaps serious damage to the apparatus under his charge.

A janitor in a school or public building should be able to pass an examination as to his fitness and ability to manage the modern appliances for heating and ventilating a schoolhouse or public building.

More is required of a janitor than the ability to shovel coal into a furnace or under a steam-boiler, or to see that a proper amount of water is in the boiler. Good judgment and a thorough knowledge of the apparatus is essential.

Besides regulating the fires properly by having good and clean fires in cold weather and light fires in moderate weather, and, with a steam-heating system, seeing that the proper

amount of radiation is in use, it is of the utmost importance that the inlets for fresh air, the mixing-damper for regulating the temperature of the air supplied to the class rooms, the heat or fans for the ventilating ducts, and the dampers for regulating the outflow of foul air, should be properly understood and managed.

In a mechanical (fan) system care should be taken that the fans are run at a proper speed and at the proper time.

ATTENTION TO INLET WINDOWS

It is very important that the windows admitting air to the cold-air rooms, where the indirect radiators or furnaces are located, are properly opened or partly closed, as may be required by the constantly varying conditions of temperature and wind. These windows should be hinged at the top and open inward in order that the air may be deflected downward and distributed through the cold-air room.

The stacks of indirect radiators or the furnace should never be placed so close to the windows that the window cannot be opened to its full capacity. When a gravity system is used the windows in the cold-air room should have an opening equal to the combined area of the several ducts leading from the cold-air room.

With a mechanical system in a large building the area of these windows may be less than in a gravity system.

In mild weather and when there is but little wind they should be kept wide open during the school session; in very cold or windy weather they should be partly closed; but under no circumstances should they be entirely closed when school is in session.

If opened too wide when a strong wind is blowing into the cold-air room, more air will be supplied than is required or can be properly warmed, and uncomfortable drafts will be felt in the school rooms.

If closed too much, a sufficient supply of fresh air will not be furnished and the air in the school rooms will be vitiated to an objectionable degree.

When on the leeward side of the building they should be opened wider than when they are on the windward side.

Each window in the cold-air rooms should be provided with a stout cord or chain and pulley and means for fastening the same, in order that the window may easily be opened or closed to any desired position.

It is also advisable to hold the window in the desired position and not allow it to fly up or down by the action of the wind. This can be done by another cord or chain.

Mixing-valves or dampers are placed in the fresh-air ducts which lead to the several rooms, by means of which the air is allowed to pass through the stacks of indirect radiators or along the heating surface of the furnace, or is caused to by-pass without going through the heaters.

By the use of mixing-dampers the temperature of the air supplied to the school rooms can be regulated without materially reducing the supply.

When valved registers are used and the room becomes too warm the heat is shut off as is also the supply of air at the same time.

TEACHERS SHOULD BE INSTRUCTED ON OPERATION OF APPARATUS

The teachers as well as the janitor frequently operate the mixing-valves and dampers, and should also be instructed in their use.

It often happens that when the school room becomes overheated the chain operating the mixing-valve is pulled in such a manner as to almost entirely shut off the warm air and turn on the cold air. Cold air is then admitted to the room and uncomfortable drafts are caused, then when the room has become too cool the chain is moved in the opposite direction and the room is soon overheated again. If this is continued the teacher or janitor will be kept busy trying to keep the room at a comfortable temperature.

If, however, when the temperature of the room begins to rise or fall below the desired points (68 to 70 degrees F.) the mixing-damper chain

is moved but a little at a time—say from one-half to one inch—there will be little difficulty in maintaining the desired temperature if the fires and the windows in the cold-air rooms are properly managed. The mixing-valve, after having been once properly adjusted, may not require to be moved during the whole or greater part of the session.

RIBBONS ATTACHED TO GRILLS

Two or three pieces of thin or narrow ribbon—about one-quarter of an inch wide and about ten inches long (red, white and blue would be appropriate colors)—tied into the wire grill at the warm-air inlet, about two-thirds the distance up from the bottom to the top and in the center of the wire grill, will be of great assistance to the teacher in determining whether or not a proper amount of fresh air is being supplied to the school room.

If the ribbon does not blow out or flutter it will indicate a deficiency in the fresh-air supply.

A metallic thermometer about four inches in diameter, which has an indicator hand, will, if placed on or in the wire grill near the ribbon, enable the teacher or janitor to place the mixing-valve in the right position.

As the outflow of air from a room through the exhaust flues or ducts is caused, in a gravity system, by the difference between the temperature of the external and internal air, and also by the force of the wind blowing across the top of the ventilating stack or flue, some means of meeting the constantly varying conditions of temperature and wind must be provided.

In a mechanical system provision should be made for regulating the flow of air through the several ducts and flues.

In both the gravity and mechanical system dampers should be placed at the outlet from each ventilated room.

The heat in the vent-flues should be used in a manner directly opposite from that used for warming the rooms. The greater the difference between the temperature of the outside and inside air, the less will be the amount of heat required in the vent-flues.

In very cold and windy weather no heat may be needed in the vent-flues, and the dampers in the outlets from the rooms may often be partly but never entirely closed while school is in session.

In mild and calm weather the dampers should be wide open and heat maintained in the vent-flue heaters. The warmer the weather, the more heat will there be required in the vent-flue heaters.

Pieces of ribbon similar to those on on the warm-air inlet should be provided for the outlets, but they should be placed on the inner side of the grill. If they flutter into the duct it will indicate an outflow of air from the room. If they blow back or rest against the grill it will indicate a reversed draft or no draft.

In cold weather, after the school session has closed, sufficient time should be allowed to flush out the room with fresh air.

The dampers at the outlets should then be closed and the heat in the vent-ducts shut off.

Leaving the dampers in the vent-ducts open at night will cause a waste of fuel and unnecessary cooling of the rooms.

In warm weather, when no heat is supplied by the warm-air inlets, the dampers may remain open at night.

After school has been dismissed for the day and the class rooms have been flushed out with fresh air from the warm-air inlets the windows admitting air to the cold-air rooms in the basement should be closed as should also the dampers in the vent-flues. The rotating registers in the floor above the cold-air rooms, as well as the doors from the several class rooms, should then be opened and the air rotated through the building by means of the indirect radiators or furnaces. The fires can then be banked and checked for the night.

In cold weather, if direct radiation has been provided in the class rooms in addition to the indirect radiation, the direct radiation should be turned on and kept on till a short time before the opening of the morning session.

If plenum fans are used they should be started in season to thoroughly warm the building by rotating the air before the opening of the morning session.

The direct radiation in class rooms should not be used while school is in session, unless the class rooms cannot be heated without it

The heat in the sanitary vent-flues should be kept up at all times, except perhaps in very cold and windy weather.

The dampers in the corridor vents should be closed at night.

WINDOWS SHOULD NOT BE OPENED IN SANITARY ROOMS

Care should be taken not to open the windows in the sanitary rooms and allow the wind to blow in, as the odors may under some conditions be driven out of these rooms into other parts of the building.

It is much better to depend upon the sanitary vent-flues to properly ventilate these rooms by drawing the odors from the room through the sanitary closets and urinals.

The janitor should be in the building in the morning in season to have the building properly heated and the ventilating apparatus in good working order before the school session opens.

After cleaning and properly starting up the fires he should open the windows admitting fresh air to the cold-air rooms and properly adjust them to meet the existing conditions of wind and outside temperature. He should then close the rotating registers, open the vent dampers to the proper degree and close the class room doors.

When the large boilers in a steam-heating system are in use the steam for heating the vent-flues should be supplied from that source; but when the large boilers are not in use, or with a furnace system of heating, the small boiler, usually called the "summer boiler," should be used.

The doors, windows and transoms should be kept closed while school is in session in order to obtain the best results from the heating and ventilating system, and to secure a proper circulation of air in the rooms.

Springs or door-checks, if provided on all outside doors, will soon repay the extra expense by the saving of coal.

Janitors should be held to a strict accountability that the heating, ventilating and sanitary appliances in the buildings under their care are managed in a manner to secure the best results.

While they should not be blamed for improperly designed or constructed apparatus, yet they should be required to secure the best possible results obtainable from the apparatus under their control and to keep the same in good condition.

The janitor should see that the boilers or furnaces are left in proper condition at the end of the school term. If a mechanical system is used all parts of it should also be attended to. If any defects develop or accidents occur to the boilers, piping, valves or other parts of a steam-heating system, or in the furnaces or stack heaters under his charge, the proper authorities should at once be notified in order that the required repairs may be made promptly.

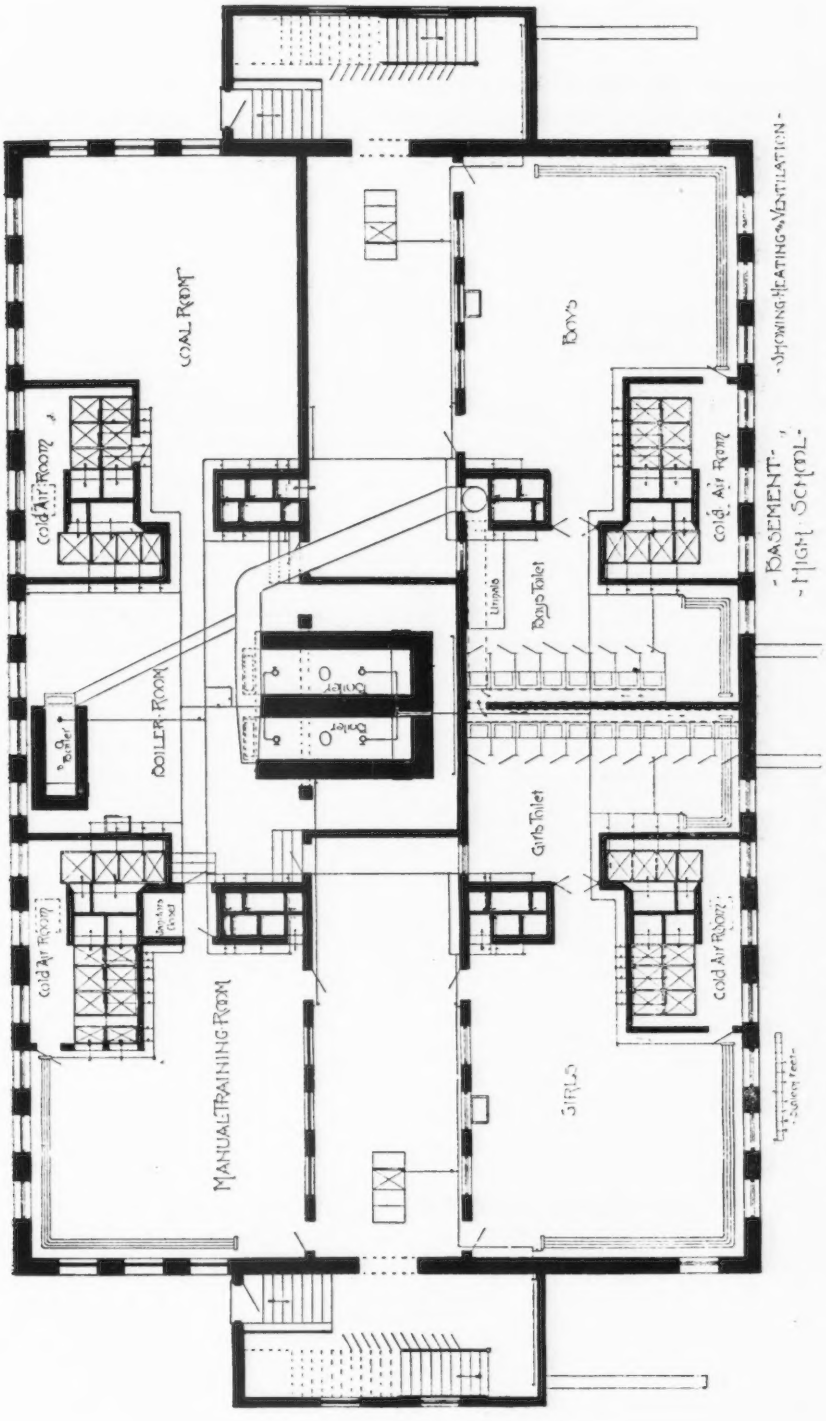
TEN TONS OF COAL PER CLASS ROOM BURNED DURING HEATING SEASON

The average annual amount of coal burned in well-heated and ventilated school buildings in Massachusetts is about ten tons per class room. This includes the basement, corridors and small rooms in an ordinary schoolhouse.

Where much in excess of this amount is used, unless in a building in a very exposed location, or one badly constructed, or where the system of heating and ventilation is badly designed, it is fair to presume that the janitor has not been careful in managing the fires.

Where, as is sometimes claimed, only seven or eight tons of coal are burned per year, it will be found that the air supply has been restricted to an amount below what is required for good ventilation.

Some janitors, either to make less work for themselves, or to establish



PLAN OF HEATING APPARATUS IN BASEMENT OF TWO-STORY HIGH SCHOOL BUILDING

a record for economy in fuel, shut off the fresh-air supply, or fail to maintain proper heat in the vent-flue heaters.

In cities and large towns much better janitor service would be obtained if a competent "head janitor" was employed and if it was made a part of his duty to see that the other janitors were fully instructed in and properly performed their duties.

It is false economy to employ, as is often done, an incompetent or lazy janitor because he can be hired cheap.

It is not advisable that one janitor should have charge of several buildings, sometimes situated at a considerable distance from each other.

Very frequently janitors do not receive suitable compensation for their work. This is more often the case in small towns than in cities. Fair compensation should be given for intelligent and faithful service.

PLANS FOR A TWO-STORY GRAMMAR OR HIGH SCHOOL

The accompanying plans are those for a small high or a grammar school, a two-story building, built of yellow brick, with yellow terra cotta trimmings and slated roof. If used as a grammar school, the rooms intended for the mechanical and physical laboratories can be used as class rooms.

In the first story are four class, two recitation and two teachers' rooms, with toilet connected.

The corner rooms, 28x32 feet and 12 feet high, are intended for forty-nine pupils. The recitation rooms are each 17 feet 8 inches by 28 feet.

The teachers' rooms, including toilets are each 11 feet 4 inches by 28 feet. The center corridor is 15 feet wide and the front corridor 12 feet wide.

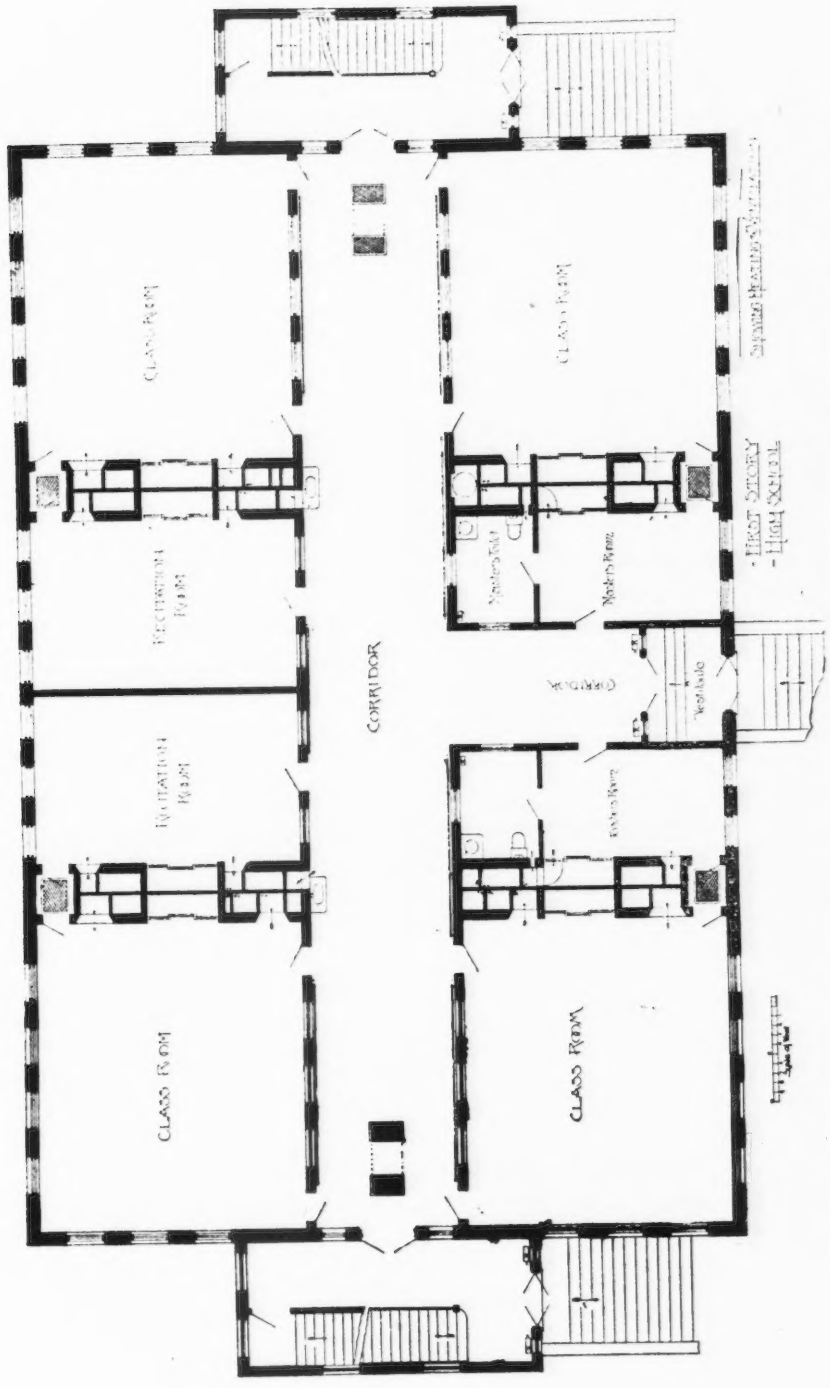
In the second story are two class rooms, a chemical and a physical laboratory, each 28 by 32 feet by 12 feet high, an assembly hall 36 by 73 feet, and two storage rooms in the stairway extension. The stairways at each end of the building are six feet wide and railed on both sides. The main doors open both ways, as do also the assembly room doors.

In the basement, which is 12 feet high, except the boiler room, which is 14 feet 6 inches in height, is a manual training room, a boys' and a girls' recreation room, sanitary rooms, boiler room and coal room, cold-air rooms and places for bicycles. Two stairways lead up to the first story and there are two doors from the outside to the stairway extension.

The building is heated by a low-pressure, two-pipe, gravity, steam system, with two horizontal tubular boilers, each 54 inches in diameter, 15 feet 3 inches long, containing 60 three-inch tubes 14 feet long; also by a smaller horizontal tubular boiler, 36 inches in diameter, 9 feet 3 inches long, containing 34 two-and-one-half-inch tubes, 8 feet long. This small boiler is intended to furnish steam for the steam pipes in the vent-ducts and for a low-pressure engine to run the turning lathes, etc., in the manual-training room when the large boilers are not in use. It can also be used to warm the radiators in the spring and fall months, when but very little heat is required for a part of the day. The three boilers are set, piped, valved and connected so that either may be used as desired. When it is necessary to use very low pressure in the larger boilers for warming the building in moderate weather, the small boiler can be used at higher pressure to run the engine for operating the lathes and also for heating the vent-flues. A reducing pressure-valve should be provided, also a separator, tank, pump, and and pump governor.

If an electric motor is used for running the lathes, it will not be necessary to use the pump, etc., the small boiler can be reduced in size and the system can be run by gravity return. This would be advisable where electric power is to be had.

By having the boiler room lower than the other parts of the basement a good return of water by gravity to the boiler is secured, and a complicated system of traps, pumps, etc., is rendered unnecessary. The supply and return pipes are of ample size, properly pitched, graded, dripped and valved, so as to secure a free and noiseless circulation and return to the boilers.



PLAN OF FIRST STORY OF HIGH SCHOOL BUILDING, SHOWING LOCATION OF REGISTERS AND FLUES

The class rooms, assembly hall, recitation rooms, laboratories and teachers' rooms are heated by stacks of indirect radiators of the H. B. Smith School Pin, Bundy Newport, American Sterling, or similar pattern, placed in the cold-air rooms in the basement; each stack being divided into three sections so that part of the whole may be used as desired.

Direct radiation is supplied in the corridor and stair extensions, and two lines of one-and-one-quarter-inch steam pipe under the clothing racks in the corridors for drying in stormy weather and for heating in extremely cold weather.

At the end of the lower corridor there are floor registers without valves for use as foot-warmers, the air being drawn down through the register nearest the door, passing through the stack of radiators, which are to be cased with galvanized iron and suspended from the basement ceiling, and coming up through the register farthest from the door. Good exhaust flues are provided from the corridors, and the leakage of air into the corridors is sufficient to keep them in good condition.

In the chemical and physical laboratories four lines of one-and-one-quarter-inch steam pipe should be placed on the two exposed sides, to be used at night to prevent freezing in extremely cold weather when the rooms are not in use.

Direct radiation is placed in the assembly hall in addition to the indirect, to keep the room partly warmed and to heat quickly when the indirect is turned on before the room is occupied. When occupied the direct should be shut off and only the indirect used.

The manual-training room in the basement is also supplied with direct and indirect radiation. The recreation rooms and sanitary rooms are warmed by lines of overhead steam pipes, the supply mains in the basement being protected by non-heat-conducting pipe covering.

The ceiling of the boiler room and the cold-air rooms, are specially protected by non-heat-conducting material placed between the flooring and the metallic lathing—in the case of of the boiler room, to prevent the heat passing up through the floor and overheating the rooms above, which often happens when the boilers are located under the school room and no protection is provided other than the wooden floors. It is advisable to construct the ceiling of iron beams and terra-cotta arches and make the boiler room fireproof.

If the cold-air rooms are not protected overhead the cold air chills the floor directly over them, sometimes to an uncomfortable degree in extremely cold weather. The cold-air room windows should be hung in two parts and be provided with cords and pulleys for opening and closing.

The fresh warm air is taken into the rooms through inlets of the same size and location as previously described in other plans.

The dimensions of each of the four warm-air flues for the assembly hall are 52 by 24 inches.

Tests of the best work show that by having the warm-air flues of liberal size the air is introduced into the rooms at a lower velocity and temperature than when the flues are too small. In moderate weather this is a decided advantage, as a sufficient amount of fresh air can be supplied without overheating the room as was the case in some of the earlier work, where the temperature had to be raised too high for comfort in order to obtain the required volume of air with small ducts.

In some cases, especially where fans or blowers have been used, the ducts have been reduced in size under pretense of cheapening the cost of construction, and the air forced into the room at a high velocity, causing uncomfortable drafts and a needless expenditure of power.

Wire grills are used instead of cast-iron registers to cover the inlets and outlets. Mixing valves are supplied for warm-air flues. Adjustable galvanized-iron cut-offs or adjusting dampers are provided at the bottom entrance for the warm air to regulate the supply of air to the several rooms under the varying conditions of wind

and temperature or to cut off the supply from any unoccupied room.

The use of double windows will be of great service in very cold and windy weather, and will to a considerable extent prevent too rapid cooling and precipitation of the air by the glass surface which often causes downward drafts in front of single windows. A considerable saving of fuel can be made by using double windows.

The openings from the rooms and corridors into the vent-flues are of the size and location previously described in other plans. Galvanized-iron dampers are also provided for these vent openings. Vent-flue heaters are installed.

By the use of steam pipes or radiators in the vent-flues a good velocity is given to the outgoing foul air, back draft is prevented without the use of flap-valves, whose chief purpose appears to be to obstruct the outflow of the foul air and to cause a disagreeable noise by flapping up and down when moved by the wind.

Experience and not theory has taught that means should always be provided for causing an outflow of the foul air through the vent-flues and ducts, either by heat or mechanical means. Attempts to cause an outflow by other methods, especially when the outlets are obstructed by worse than useless flexible valves, which are liable to close when the room is occupied and ventilation required, and to open when the room is unoccupied and no ventilation needed, usually result in noticeable failures, as proved by numerous tests.

With these contrivances there appears to be no practicable way of adjusting the outflow, and in extremely cold and windy weather, when the outflow will need checking, the flap-valves will be open to their full capacity; but in mild and calm weather, when they should be wide open, they are liable to be closed.

Use of Boilers in Massachusetts Schools

Water-tube boilers are used to a limited extent in schoolhouses in Massachusetts; generally where a mechanical (fan) system of heating and ventilation has been installed, or where the architect has not provided a boiler room of sufficient size.

Upright tubular boilers have been used in schoolhouses; but to a limited extent and where it has been desired to run an engine at high pressure to drive a fan or blower.

They occupy but little floor space, but in the ordinary schoolhouse basement require that a pit be provided to keep the top of the boiler sufficiently below the ceiling.

It is generally better to use a low-pressure engine having a cylinder of large diameter and short stroke, rather than to install a high-pressure engine driven by steam at high pressure from an upright boiler.

CAST IRON SECTIONAL BOILERS

Cast-iron sectional boilers have been used to a considerable extent in schoolhouses.

A large factor of safety should be allowed for raising many of this class of boilers. In installing them in schoolhouses it is well to obtain from the manufacturer a good and sufficient guarantee that the boiler will do the work required.

Some boilers in this class have a large amount of heating surface and a small amount of water and steam space, and when forced the water is carried into the heating coils or radiators and trouble is caused by low water in the boiler, melting out the fusible plug and cracking sections of the boiler.

The writer has seen cases where this has occurred and caused the shutting down of the heating apparatus. This has been noticeable in some of the small cast-iron sectional boilers so generally used for heating the vent shafts and for supplying direct radiation in corridors, teachers' rooms, etc., in schoolhouses.

Where this class of boiler is used care should be taken to select a boiler of ample size to do the work required, and one that has a proper proportion of heating surface to the water and steam space; also one that does not have a large, flat, unstayed heating surface.

Materials and Properties of Wrought Pipe *

By F. N. Speller

It is not within the scope of this paper to discuss in detail the processes of manufacture of welded pipe, nor would there be time; that portion of the subject has been fully treated in papers previously read before this Society. The object is to draw attention more particularly to certain characteristics possessed by the metals used in the manufacture of modern welded pipe and certain qualities which have considerably widened the field of use for tubular goods.

Before considering the properties of the materials, some photographs are shown illustrating the chief operations involved in the metallurgy of pipe material, and the manufacture of welded tubes and pipe. The photographs were taken in the works of the National Tube Company, and show examples of the old methods of working, as well as the extensive modern mills which are now taking their place.

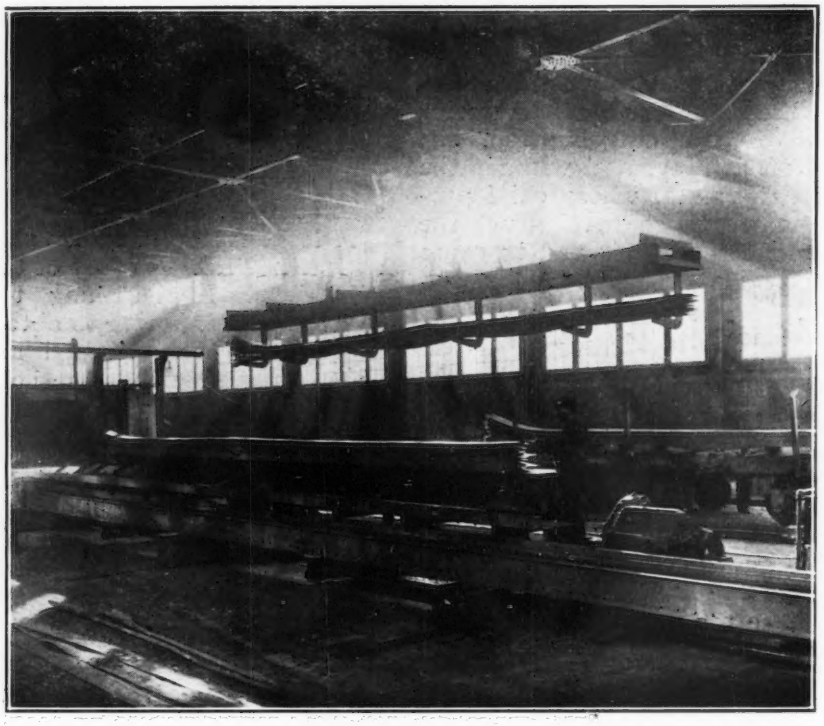


FIG. 1—CHARGING DOUBLE LENGTH BUTT-WELD FURNACE

For years wrought iron was the only material available for this purpose, but within the past fifteen years the making of weld-steel has become a special branch of the steel industry and furnishes a material having many advantages for mechanical welding operations.

Enumerating the chief metallurgical processes in historical order, we have, first;—the making of charcoal iron from charcoal pig iron: The silicon and manganese are first almost completely removed by melting the pig iron in the refinery or run out fire. The plate metal from this furnace is further refined in the "knobbing fire," using charcoal for fuel. This is interesting as being a slightly modified form of the furnace used in the early days of the iron industry for the making of wrought iron and steel direct from the ore. The bloom produced is repeatedly heated and hammered, and finally rolled into a bar, which is re-piled four or five high, heated to a welding temperature, and rolled into a plate, preferably in a continuous mill. This is the finest wrought iron which can be made, and is still used in the tube works, although in decreasing amounts, principally in the manufacture of boiler tubes. The following average analyses of several heats will indicate the progress of the refining at each operation.

The puddling furnace furnishes wrought iron of a much coarser grade better adapted

* From a paper read before the Engineers Society of Western Pennsylvania, and published in the proceedings for January, 1907.

	Total Carbon	Manganese	Silicon	Phosphorus	Sulphur	Oxides and Cinder
Pig Iron	3.85%	.980	.940	.086	.025	....
Refinery Metal	3.50 (Comb)	Trace	.210	.070	.024	....
Finished Plate	Trace	Trace	.014	.024	.014	.92

for standard pipe, having the following average composition:

Silicon	.100
Phosphorus	.200
Sulphide	.020
Manganese	Trace
Carbon	Trace
Oxides and Slag	2%

The strenuous nature of the work is well known to anyone who has watched a puddler around his furnace. An hour and a half's operation in the furnace reduces the charge of pig iron to a 500-lb. mass of refined iron of pasty consistency, which is divided into two balls to facilitate handling. The product is unfortunately hard to regulate in quality on account of the irregularities in composition of pig iron used; the small quantity made in one heat; and the amount of personal attention and skill required on the part of the puddler and the large personal equation thereby introduced.

Iron made by this process to-day is rendered still more unreliable by the practice of intermixing steel scrap of various composition.

By carrying the Bessemer process to the limit of refining, and treating the metal so as to give the best results in welding a refined iron is produced practically uniform in quality, which will roll into a plate with a true edge, a very desirable condition for good results in the pipe mills. To obtain the best results it is necessary to manufacture "pipe steel" on a scale sufficiently large to take the full capacity of a steel plant. Under these conditions it is probably safe to say that a uniformity of product is obtained unequalled by any other class of steel manufactured on this scale.

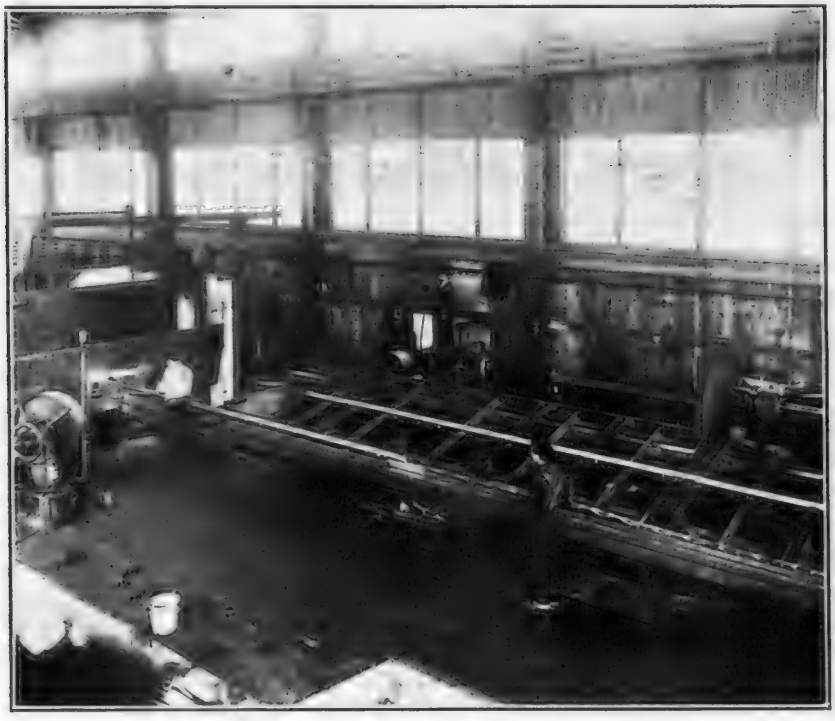


FIG. 2—DRAWING BUTT-WELD PIPE

A smaller proportion of pipe steel is made by the Basic Open Hearth process, but the easy control and continuous supply of uniformly very low carbon steel which can be had from a Bessemer plant running in conjunction with pipe and tube mills, and the satisfactory nature of the product, has caused the Bessemer process to become generally used for this class of work. The higher phosphorus and sulphur contents are no objection in welded pipe where the quantity of metal used is so greatly in excess of what strength requires, and moreover these elements become a necessity if the pipe is to be tolerably easy to thread.

Pipe steel welds with greater ease and

FIG. 3—CHARGING END OF LAP-WELD FURNACE, SHOWING ALSO BENDING OF PLATE

with much less loss on account of blisters and laminations than wrought iron.

A type of mill for rolling skelp has been shown, also photographs of the latest modern butt and lap weld mills, the former making 40-foot lengths up to 3 inches diameter, and the latter welding pipe up to 36 inches in diameter.

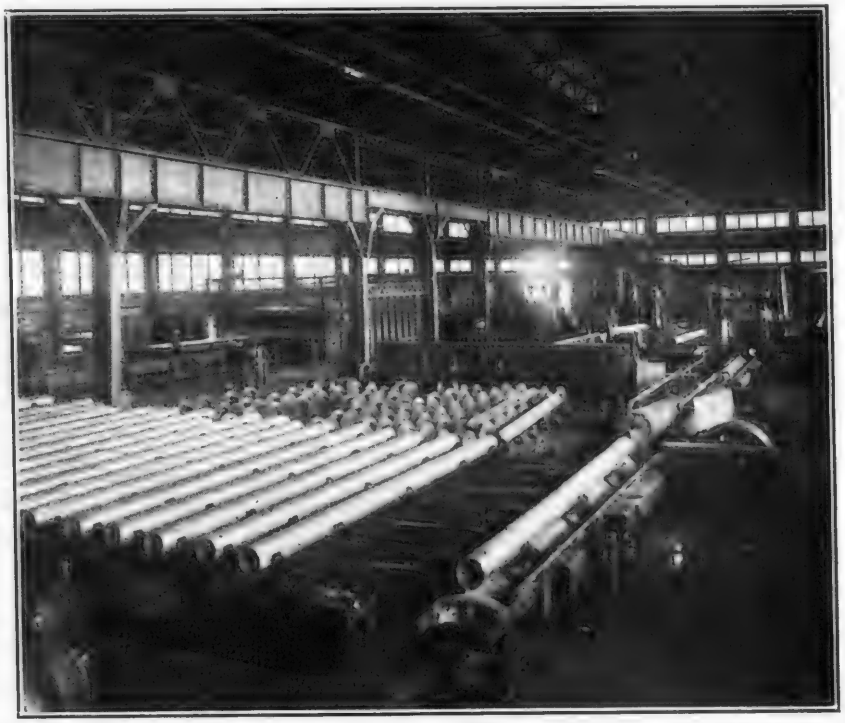


FIG. 4—GENERAL ARRANGEMENT, FINISHED END, LAP-WELD FURNACE

GROWTH OF TUBE AND PIPE INDUSTRY

The production of welded tubes and pipe has almost doubled in tonnage since 1899. During this period the process of making pipe steel and mechanical welding by the butt and lap weld process has been much improved, giving a more uniform product and at the same time reducing costs all

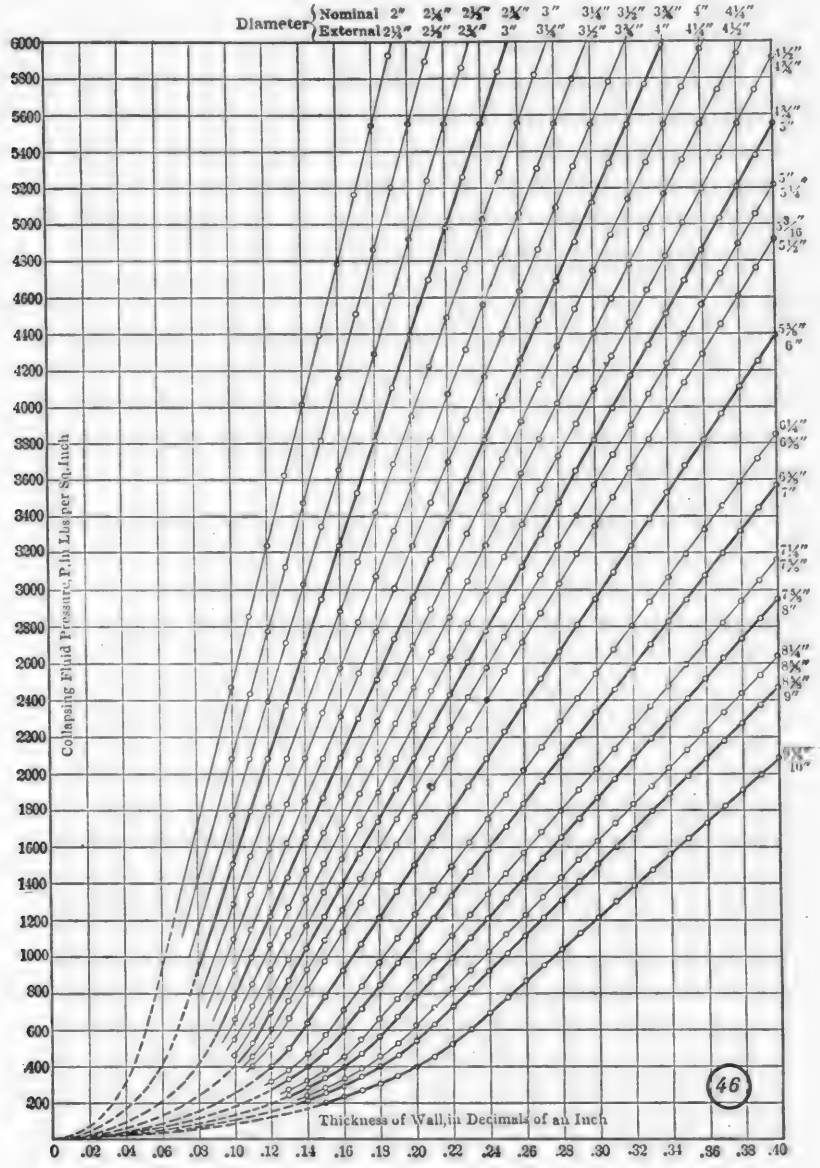


FIG. 5—DIAGRAM OF COLLAPSING PRESSURES

round. The introduction of pipe steel has apparently had somewhat the same influence in expanding the field of use for tubular goods as the advent of structural steel exercised on the production of materials of construction formerly made of wrought iron. Last year (1905) the production of tubular goods in the United States (1,435,995 tons) nearly equalled that of rolled structural shapes (1,660,519 tons) not including plate. The demand this year promises to reach 1,700,000 tons.

The generally good welding quality of wrought iron enabled it to maintain its position for the manufacture of pipe years after it had been displaced by steel as a material for general engineering construction. In 1890 about 3 per cent of the welded pipe was made of steel; in 1905 this had increased to 70 per cent., and it is estimated that steel pipe will constitute 80 per cent. of the output for 1906. Besides the general use of pipe in steam, water, gas and oil lines, which consumes the

larger part of the tonnage, increased amounts are being used for trolley poles, electric conduits, bedstead construction and for other special purposes.

Among the special uses to which steel pipe lends itself, the catenary system of trolley suspension might be referred to. Large quantities of the small sizes of extra strong pipe are used in making the light triangular frames from which the live wire is suspended in high speed electric railroad construction. The joints are either threaded, or flattened and pinned together. Steel pipe combines a maximum strength with a minimum weight, which is very desirable for such work. Wherever pipe has to be bent or worked either hot or cold the modern material has a decided advantage.

In the California field a quantity of steel pipe has been rifled, the object being to cause the viscous oil intermixed with a small per cent. of water to whirl as it moves rapidly through the pipe, thus when a sufficient velocity is attained, a layer of water flows between the oil and the pipe reducing the friction in the line.

It has been found quite practicable to roll spiral corrugations 3-32 inches deep in the surface of the pipe by means of six wheels set equidistant around the circumference and slightly inclined to the axis of the pipe, so as to make a complete revolution on the surface of the pipe every 10 feet. The material appears to stand this treatment cold without difficulty.

It might be well to refer here to the heat treatment necessary to anneal pipe steel. The heat required to weld iron or steel produces a larger grain in the metal. For most purposes this does no harm and steel pipe unannealed will stand severe cold bending without fracture, having an elongation of 20 per cent. to 22 per cent. in this state, but where the pipe has to be worked hot it is advantageous to first heat to a full orange (above the critical range or 900 degrees C.) for a few minutes and allow it to cool in the air. This will completely remove all possible effect of overheating by refining the grain, and will enable the metal to be worked without danger from red shortness. Tubes or pipe will also stand more cold working without fatigue if so annealed.

PRINCIPAL PHYSICAL CHARACTERISTICS OF PIPE MATERIALS

From the manufacturing standpoint, the superior welding quality, uniformity and lower cost of pipe steel are the determining qualities. These cannot, however, be obtained to good advantage without working on a large scale and manufacturing this grade of steel exclusively. The tensile strength of pipe steel pulled transversely is about double that of wrought iron, hence the welded seam might be expected to be proportionately strong. This has been shown to be true by experiments on 2-inch butt welded pipe. The average strength of the weld was thus found to be 70-72 per cent. of the strength of the metal transversely in each case, and the steel weld proved to be twice as strong as the wrought iron. Bursting tests on wrought iron and steel butt welded pipe confirm these conclusions. The strength of the seams was compared by twisting pieces 8 feet long until they failed. Results were obtained on three sizes of standard pipe and the appearance of the pieces after testing can be judged by Fig. 6.

TABLE I.—TWISTING TESTS ON BUTT-WELDED PIPE.* SUMMARY.

Size	Material	Make	Wt. per ft. lbs.	Variation from card wt. %	Max. 3 foot Low	Pull on lever High	Lbs. av.	No. of turns in 6 ft. before failure	% failed in weld
⅛ inch.....	Steel	N. T. Co.	.816	−2.2	90	120	109	15	0
⅛ inch.....	Iron	1	.803	−4.2	40	98	68½	4½	73
⅛ inch.....	Iron	2	.792	−5.2	20	113	81	5¾	66
⅛ inch.....	Iron	3	.842	+0.6	50	85	65	2½	100
¼ inch.....	Steel	N. T. Co.	1.082	−2.9	160	185	172	8	13
¼ inch.....	Iron	1	1.079	−3.1	15	160	125	3¾	57
¼ inch.....	Iron	2	1.127	+1.0	80	176	136	3½	66
¼ inch.....	Iron	3	1.104	−1.0	50	160	107	2½	90
1 inch.....	Steel	N. T. Co.	1.658	−0.7	180	340	300	5½	13
1 inch.....	Iron	1	1.593	−4.4	220	292	256	4½	46
1 inch.....	Iron	2	1.616	−3.1	170	300	250	3½	33
1 inch.....	Iron	3	1.620	−2.8	100	320	258	2¾	66

*From T. N. Thomson's paper—"Power required to Thread, Twist and Split Wrought Iron and Mild Steel Pipes," before the American Society of Heating and Ventilating Engineers, January, 1906. [Published in the January, 1906, issue of THE HEATING AND VENTILATING MAGAZINE. ED.]

Pipe steel finishes with a smoother surface than wrought iron, which for some purposes is very desirable.

A list of the physical properties of steel pipe would not be complete without referring to the exhaustive series of tests made on the National Tube Company's lap weld steel pipe by Prof. R. T. Stewart, to determine the collapsing pressures.* This work occupied one to six men four years and involved the collapsing of nearly four hundred pieces of pipe, 3 to 10 inches in diameter, mostly 20 feet in length.

Fig. 5 gives the collapsing pressure for all sizes and gauges from 3 to 10 inches diameter, and for all lengths over six times the diameter.

CORROSION OF IRON AND STEEL

This is a question which has brought forth many opinions, but in most cases with little practical evidence. After investigating closely many cases which have come under my observation during the past two years, where the two materials

*[An exhaustive review of this paper appeared in the May, 1906, issue of THE HEATING AND VENTILATING MAGAZINE. ED.]

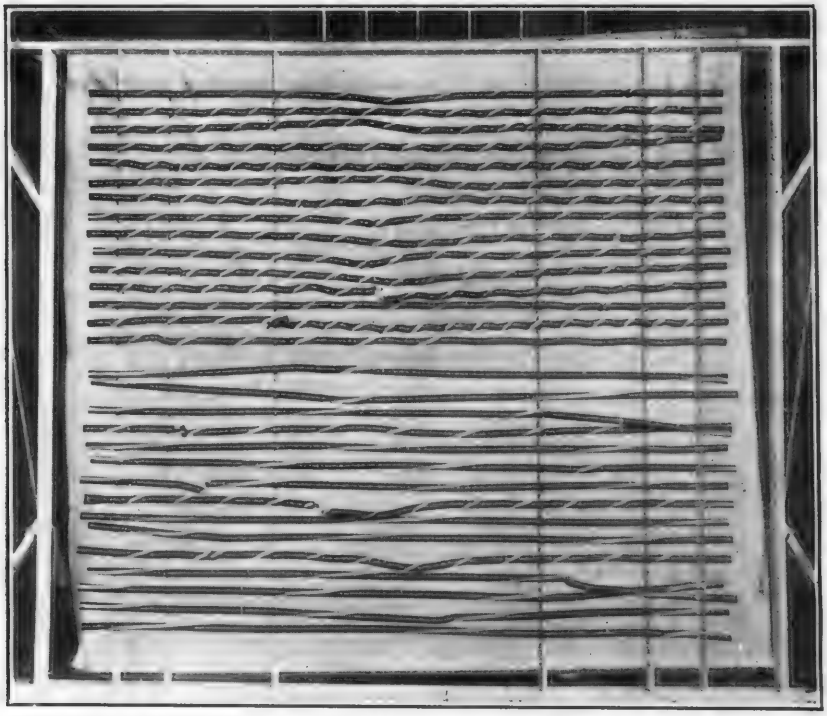


FIG. 6—TWISTING TESTS

were put in service together and subject to the same conditions, I have never yet found any decided difference. The impression which exists in some minds that wrought-iron pipe is much superior to steel in durability, may have originated in comparisons made years ago when the practice of making sound low carbon steel was probably not so well understood as it is to-day, or it may have been a mistaken identity, for we frequently find iron mistaken for steel, especially if it happens for some cause or other to be pitted, but in most cases the idea has apparently been spread by hearsay and accepted without investigation.

In view of the inherent differences between iron and steel made for various uses, it would seem safer to compare each class by itself, i. e., wire, sheet, pipe, etc., each under the conditions of service to which they are subjected.

The essential conditions of corrosion, air, water and carbonic acid, are easily duplicated in the laboratory, but in practice corrosion is accelerated by presence of sulphurous and other solutions, stray electric currents, heat and numerous other influences difficult to trace.

It will be conceded that such conditions tending to seriously affect corrosion, are rapidly on the increase, especially in and

TABLE II.—AVERAGE RESULTS OF RECENT COMPARATIVE TESTS ON CORROSION OF WROUGHT IRON AND PIPE STEEL.

(Losses per unit of surface exposed compared with puddled iron as 100.)

Conditions of Test	Authority	Duration of Test	Charcoal Iron	Puddled Iron	Pipe Steel	Test Started
1. Aerated Distilled Water Normal Temp.	U. S. Navy Dept.	64 weeks	100		94.5	1901
2. Sea Water. Normal Temp.	H. M. Howe	2 years		100	119	1897
3. Aerated Brine. Normal Temp.	Lab'ry Nat'l Tube	6 months		100	106	1904
4. Aerated Water. 180 degrees F.	Lab'ry Nat'l Tube	3 months		100	90.6	1905
5. Aerated Brine. 180 degrees F.	Lab'ry Nat'l Tube	3 months	80	100	75.3	1906
6. Aerated Sea Water. 180 degrees F.	Howe	3 months	94.4	100	94.2	1906

near the great centers of population. Hence we should be slow to draw conclusions from the statement that steel does not last now-a-days as it did 15 or 20 years ago. Whatever was the relative standing of the two materials years ago (and opinions differ widely) what we are more concerned with is how do they stand to-day, and how can they be best protected from corrosion?

Laboratory results, while open to criticism, as not truly representing actual conditions in the field, are valuable as indicating the relative standing of a number of samples under conditions known to be uniform—something difficult to be sure of in service tests.

The writer has in his tests lately, used a 5 per cent. hot solution of brine through which a continuous flow of air is pumped. One reason for adopting this solution is that a number of tests are on record which indicate that steel in general seems to be somewhat more susceptible to this environment than wrought iron, and further that the loss is quite considerable in a reasonable time (about 1-10 gram. per sq. in. per month). A number of average results on pipe materials are given in Table II., comparison being made with good wrought iron as a standard.

There are two possible ways of protecting steel: 1st, by use of efficient protective coatings; 2nd, by treatment of the metal in the course of manufacture. Experiments have been under way for some time at the works of the National Tube Company with the object of increasing the durability of pipe steel. As a first step in this direction a process has been developed which after a year and a half's trial has given results showing a decided benefit to the steel, especially in the uniformity with which it corrodes. The treatment consists in a mechanical working or kneading of the metal which tends to produce greater uniformity and improve the quality and texture of the steel. Doubtless much of the steel does not need this treatment, but in such cases it does no harm, and on the whole raises the average standard of the output. Tests marked No. 4, 5 and 6 were made on this steel.

FIG. 7—CHASERS PROPERLY GROUND FOR THREADING STEEL PIPE

It has been recognized that service tests must be made before any certain conclusion can be reached. A number of such tests have been made on this steel pipe in sulphurous air, salt water, and mine water during the past year, precautions being taken to have an equal number of pieces of "genuine" wrought-iron pipe alongside under the same conditions. One or two tests which have been made in this way in sulphurous mine water are shown to illustrate the comparative uniform corrosion of the steel. The results so far have shown the steel so treated without exception to be at least the equal and generally decidedly superior to wrought iron.

Standardization of Cast-Iron Heating and Ventilating Pipes*

By Louis F. Pearson

[Editor's Note.—*Although cast-iron pipe is seldom used in this country for heating work, except in cases of long underground hot-water carries, such as those experienced in greenhouse and similar types of heating, the following paper offers some interesting suggestions on the general subject of pipe and fitting standardization that are particularly timely in view of the efforts now being made, through a committee of the National Association of Master Steam and Hot Water Fitters, to standardize the more important materials used by the pipe-fitting trade in this country.*]

The need of standardization is felt more by heating and ventilating engineers than by any other class, and for this reason—that more than 75 per cent. of their work is done away from home, away from machine tools, away from motive power, and away from their own personal supervision, so that when cases of pipes with threads that will not fit the connections, cast pipes with spigots too large for another make of socket; valves with flanges too small for the pipe; smoke pipe with sockets too small for the boiler outlet, brass valves with unions of a different thread than the radiator bushings; and many other troubles I am sure you are all only too familiar with, and which difficulties (nine-tenths of which are due to want of standards) are far more troublesome to deal with than if they occurred in your own workshop, where you would have every facility for handling them.

For this reason, if for no other, I think it behooves you, gentlemen, to give this work of standardization your hearty support, and, where possible, to specify and use nothing but standard goods as soon as they are to be purchased. In asking you to do this I have no personal axe to grind, for, speaking as a manufacturer, the blessings of standardization are enveloped in a considerable amount of very expensive and very troublesome fog. New patterns, new plant, and, in many cases, new machinery are serious things for the manufacturer to face before he is able to produce standard goods, and so long as the engineer is content to purchase his (the manufacturer's) particular size or gauge of pipes, or whatever he makes, why should he trouble to produce anything else?

[The speaker here reviewed the work that had been done in the way of standardization by the principal engineering societies of England. Under the direction of a main committee, made up of members of the five largest engineering societies, are twelve sectional committees and twenty-four subcommittees, making a total of thirty-six in all. Among the articles which are being standardized are various parts of steam engines, pipe flanges, screw threads, generators and motors, cast pipes for water, and cast-iron pipes for heating, ventilating and house drainage. The full committee has been working since 1904 on the subject. The work of standardizing heating, ventilating and soil pipes was assigned to a subcommittee, of which Mr. Preston is chairman. The other members of the committee, which includes manufacturers as well as contractors, are J. Nelson Russell, Walter Jones, C. Mason, A. K. Steven, John Cameron and C. W. Dawson; also F. T. Reade, an architect, and two representatives of London County Council.]

The three standards which are probably of the greatest interest to heating and ventilating engineers are: (1) Pipe threads, (2) cast pipes and (3) pipe flanges, as I presume there is scarcely one of our members who does not come in contact almost daily with one or other of these articles.

I now propose to give you a short account of the work done by the subcommittee which has been selected to deal with cast pipes.

Low-Pressure Heating Pipes

In formulating the standards for these pipes and fittings, the committee thought that the most important points to be considered were, first, the internal diameters, and, second, the weights of each size of pipes, for, on examining the various tables of dimensions which the prin-

*From a paper read before the British Institution of Heating and Ventilating Engineers, February 19, 1907, in London, England.

TABLE 1. PROPOSED BRITISH STANDARD LOW PRESSURE HEATING PIPES

For Working Pressures up to 100 feet head

		SIZE OF PIPE							
		Ins. 2	Ins. 3	Ins. 4	Ins. 5	Ins. 6	Ins. 7	Ins. 8	Ins. 9
PIPE.	Internal Diameter	A							
	Approximate External Diameter	B	2 3-8	3 7-16	4 15-32	5 9-16	6 5-8	7 11-16	8 3-4	9 13-16
	Thickness	C	3-16	7-32	15-64	9-32	5-16	11-32	3-8	13-32
	Diameter of Spigot Bead and Astragal	D1 D2	2 5-8	3 3-4	4 25-32	5 15-16	7	8 1-8	9 3-16	10 5-16
	Projection of Spigot Bead and Astragal	E1 E2	1-8	5-32	9-64	3-16	3-16	7-32	7-32	1-4
	Width of Spigot Bead	F	5-16	3-8	7-16	1-2	1-2	9-16	5-8	11-16
	Radius of Spigot Bead	G	5-16	3-8	7-16	1-2	1-2	9-16	5-8	11-16
	Width of Astragal	H	9-16	5-8	11-16	3-4	3-4	3-4	7-8	7-8
	Clearance	I	1-8	3-32	7-64	1-8	1-8	1-8	5-32	5-32
SOCKET.	Internal Diameter	J	2 7-8	3 15-16	5	6 3-16	7 1-4	8 3-8	9 1-2	10 5-8
	External Diameter	K	3 7-16	4 9-16	5 21-32	6 15-16	8 1-16	9 1-4	10 7-16	11 5-8
	Thickness	L	9-32	5-16	21-64	3-8	13-32	7-16	15-32	1-2
	Internal Depth	M	3	3 1-2	4	4	4 1-2	4 1-2	5	5
	Internal Radius	O	7-16	15-32	1-2	19-32	5-8	11-16	3-4	13-16
	External Radius	P	9-16	9-16	5-8	11-16	3-4	3-4	7-8	15-16
	Diameter of Beads	Q	3 15-16	5 1-4	6 13-32	7 11-16	8 15-16	10 1-8	11 7-16	12 5-8
	Width of Beads	R	9-16	25-32	13-16	7-8	1	1	1 1-8	1 1-8
	Projection of Beads	S	1-4	11-32	3-8	3-8	7-16	7-16	1-2	1-2
	Distance between Beads	T	1 3-8	1 7-16	1 19-32	1 15-32	1 11-16	1 3-4	1 15-16	1 13-16
	Distance of Bead from End	U	1 4	1-4	3-8	3-8	3-8	3-8	3-8	7-16
	Taper on End	V	1-16	1-16	3-32	3-32	3-32	3-32	1-8	1-8
	Width of Rest at Top	W	7-16	21-32	5-8	11-16	3-4	3-4	7-8	7-8
	Width of Rest at Bottom	Y	9-16	25-32	13-16	7-8	1	1	1 1-8	1 1-8

WEIGHT OF PIPE

Overall Length. Feet.	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
3	15	24	32	50	67	86	108	130
6	27	45	62	94	125	160	201	243
9	—	66	90	138	182	234	294	356

cipal manufacturers had submitted, it was found that the internal diameter of pipes of nominally the same diameter varied as much as one-quarter of an inch, and that there was a variation in the weights of as much as 20 pounds, in a 9-foot length of 4-inch hot-water pipe, and even a greater variation in pipes of a larger diameter.

For example, one manufacturer makes a 6-inch pipe 5 15-16 inches in the bore and weighing 210 pounds per length, while another produces a pipe 5 11-16 inches in the bore, weighing 168 pounds per length. Both of these pipes are sold as 6-inch pipes, and the heating engineer often wonders why there is so much variation in the prices quoted for nominally the same class of pipe.

The committee therefore thought it absolutely essential that in all classes of pipes under consideration the internal diameter shall in no case be less than the nominal diameter.

The length of pipes has been a subject much discussed, but it was eventually decided that the nominal length should be the over-all measurement, while for recognizing the desirability of the pipes measuring the standard lengths when laid, the committee felt that this recommendation would involve a very great expense to manufacturers in alterations to existing patterns, boxes and other equipment of the plant, and in view of the fact that heating and ventilating pipes are universally sold by the yard, it was decided that the over-all lengths should be the standard measurement. The following are the principal points mentioned in the proposed "Standard Specification":

THE PROPOSED STANDARD SPECIFICATION

1. The pipes and castings shall conform in every respect to the schedule and drawings attached to this specification, and the internal diameter shall in no case be less than the nominal diameter. The astragals and bends shall be placed as shown in the drawing (Fig. 1).

2. The pipes shall be made from remelted iron and the metal shall be dark gray on fracture.

3. The pipes may be cast horizontally.

4. The pipes shall be free from sandholes and cold shuts; shall be clean and smooth internally and externally; shall have their internal and external surfaces concentric, and shall be carefully fettled.

5. The straight pipes shall be made in

TABLE 2. PROPOSED BRITISH STANDARD LOW PRESSURE PIPE FITTING

		Ins. 2	Ins. 3	Ins. 4	Ins. 5	Ins. 6	Ins. 7	Ins. 8	Ins. 9
Diameter of Pipe	A								
Centres of Syphons	B	4 1-8	5 1-2	6 3-4	8	9 1-4	10 1-2	12	13 1-2
Length of Syphons	C	5 3-4	6 13-16	8 1-8	8 3-4	9 7-8	10 5-8	11 15-16	12 3-4
Length of Spigot	D	9	10	11 1-2	13	14 1-2	16	17 1-2	19
Radius of Sweep	E	7-8	1 1-16	1 1-8	1 1-4	1 3-8	1 3-8	1 11-16	1 7-8
Radius of Sweep	F	9-16	9-16	5-8	11-16	3-4	3-4	7-8	15-16
Radius of Sweep	G	2 1-16	2 3-4	3 3-8	4	4 5-8	5 1-4	6	6 3-4

the following lengths, which are inclusive of the depth of the socket: 2-inch internal diameter, 3-foot and 6-foot lengths; 3-inch and over, internal diameter, 3-foot, 6-foot and 9-foot lengths. The pipes dealt with in this specification shall be of not less weight than that specified in the schedule. The weight specified in the schedule shall be worked to in preference to the outside diameter, which is taken approximately to the nearest 1-32 inch. Any pipe weighing less than the scheduled weight shall be liable to rejection.

6. All fittings and other special castings shall be accurately molded and shall be made in conformity with this specification and with the schedule and drawings hereunto annexed. The sections of all fittings shall conform to the dimensions shown in the table for the straight pipes (Table 1).

7. Every pipe and casting shall have cast upon the socket in a legible manner a figure indicating the internal diameter, and also class letters H. W. (hot water), to indicate the purpose for which the pipe or casting is required.

8. All sizes of low-pressure heating pipes and fittings shall be tested by an internal hydraulic pressure of 100 pounds per square inch, and they shall withstand such pressures without showing any leakage, sweating, or defect of any kind. The pressure shall be maintained for at least two minutes. Care shall be taken that all air is extracted before the test is commenced. While under this pressure each pipe shall be struck off all over with a hand hammer weighing approximately ¼ pound.

FEATURES OF THE STANDARD SPECIFICATION

It will be noted in the foregoing specification that especial stress is laid on the necessity of heating pipes being "full bore" and "full weight," for, as these

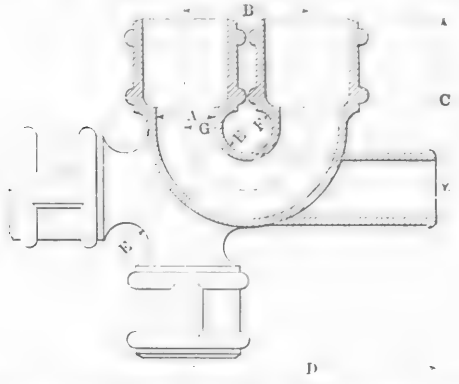


FIG. 2—PROPOSED BRITISH STANDARD LOW PRESSURE PIPE FITTING

pipes are sold by the yard, there is no fear of manufacturers making them either too large or too heavy; in fact, it may be said that the present "bastard" sizes of pipes have come to be made almost entirely through the desire of manufacturers to produce lighter goods, and

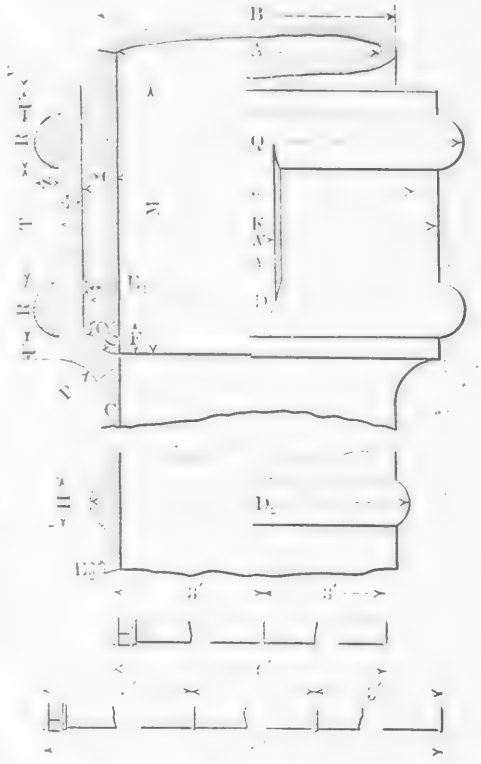


FIG. 1—PROPOSED BRITISH STANDARD LOW PRESSURE HEATING PIPE

this again has been caused by engineers endeavoring to purchase pipes below a price that they could be produced at; but I have no doubt that heating engineers suffer quite as much as manufacturers from this present-day competition and love of something "cheap," which we have all found from experience generally means something "nasty."

Another thing that has produced goods below the nominal size, especially among gutters and other rain-water goods, is the fact that manufacturers have often taken their competitors' castings and turned them into patterns, and, of course, the casting so produced is two contractions smaller than the original.

PIPE FITTINGS

In dealing with low-pressure hot-water pipe fittings, the committee decided that all sockets, thickness of metal, etc., were to follow, as far as possible, the specifications arranged for the pipes. The length of spigots on bends, tees, etc., perhaps, caused more discussion than any other detail, as up to the present no two makers in the country have the same

length of spigot, and, in some cases, the variation is very considerable.

Take the case of 2-inch bends. One firm makes these with a spigot 6¼ inches long, while another supplies a fitting with a spigot 10 inches long. In both cases the measurement was taken from center of pipe to end of spigot. We have

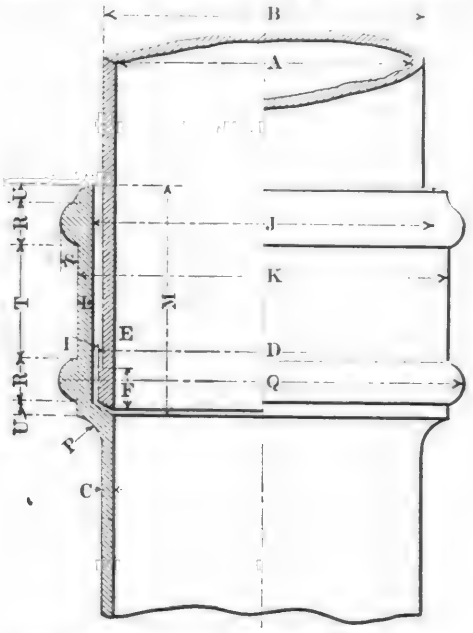


FIG. 3—PROPOSED BRITISH STANDARD FLUE OR SMOKE PIPE

also found cases where the length of spigots for 4-inch bends varied from 9 inches to 13¼ inches.

The first manufacturer would probably say "our bends are neat in appearance, cheap, and, when caulked together, the spigot end is almost covered by the socket of the pipe." The second would probably forget to point out that his bends were dearer, but would make a feature of the extra length of spigot, enabling the workmen to caulk them in much less time, and, in all probability, make a better joint; also, that the extra four inches of spigot saved an equal amount of pipe.

It has been the endeavor of the committee to steer a course between these two extremes and standardize a fitting with sufficient length of spigot that will enable a joint to be made both quickly and securely, and, at the same time, not be so long as to be unsightly, or too dear to meet the every-day commercial requirements.

I think it will be seen from the illustration (Fig. 2) and dimensions given in Table 2 that these objects have been obtained, and that the spigots will answer all reasonable purposes, for, of course, there is nothing to prevent manufacturers from making special bends with extra lengths of spigot to suit the requirements of walls, floors, etc., and I am sure the engineer will not object to paying a reasonable "extra" for them.

CAST-IRON FLUE OR SMOKE PIPE

In dealing with smoke pipes the committee has, as far as possible, followed the same lines that I have mentioned with regard to heating pipes, and have strongly emphasized the importance of the internal diameter of all pipes and fittings being the same size as the nominal diameter, for it has been found that the internal diameter of pipes being used at the present time vary considerably, and such variation the committee considers extremely undesirable, both from a technical and commercial point of view, and, I am sure, all heating engineers will thoroughly agree with us. These latter remarks apply equally to the weights of smoke pipes, which vary as much, or even more, than heating pipes, especially in the larger sizes, the weights of nominally the same size of pipe having a variation of as much as 25 pounds in a 6-foot length. The length of smoke pipes has also been dealt with in the same way as heating pipes, and the nominal length made the over-all length; that is, inclusive of the socket, for the same reasons that I have mentioned in the early part of this paper.

The committee has not yet fully considered the question of smoke-pipe fittings, but it has been provisionally decided to standardize the following angles for bends, viz., 90 degrees, 112½ degrees, 135 degrees. At the present time there appears to be no standard "easy bends," which appear to vary from 108 degrees to 140 degrees and I have no doubt that many of you have experienced the difficulty of trying to work in two easy bends under the impression that

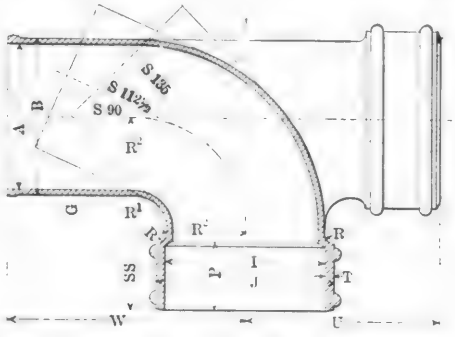


FIG. 4—PROPOSED BRITISH STANDARD SMOKE PIPE BEND

they were a true octagon (viz., 135 degrees).

In studying the foregoing tables and sketches of heating and smoke pipes, it must be clearly understood that nothing has been definitely standardized as yet, and that the details I have given are merely the recommendations of the sub-

TABLE 3.—PROPOSED BRITISH STANDARD FLUE OR SMOKE PIPES

SIZE OF PIPE

			Ins. 4	Ins. 4 1-4	Ins. 5	Ins. 6	Ins. 7	Ins. 8	Ins. 9	Ins. 10	Ins. 12
PIPE.	Internal Diam.. Approximate	A									
	External Diam.	B	4 1-4	4 3-4	5 1-4	6 5-16	7 3-8	8 7-16	9 1-2	10 9-16	12 5-8
	Thickness.....	C	1-8	1-8	1-8	5-32	3-16	7 -32	1-4	9-32	5-16
	Diameter of Spigot Band..	D	4 3-8	4 7-8	5 3-8	6 7-16	7 1-2	8 9-16	9 3-4	10 13-16	12 7-8
	Projection of Spigot Band..	E	1-16	1-16	1-16	1-16	1-16	1-16	1-8	1-8	1-8
	Width of Spigot Band.....	F	1-2	9-16	5-8	3-4	7-8	1	1 1-8	1 1-4	1 1-2
	Clearance	I	1-8	1-8	1-8	5-32	5-32	3-16	3-16	7-32	7-32
SOCKET.	Internal Diam..	J	4 5-8	5 1-8	5 5-8	6 3-4	7 13-16	8 15-16	10 1-8	11 1-4	13 5-16
	External Diam.	K	5	5 1-2	6	7 3-16	8 5-16	9 1-2	10 3-4	11 7-8	14 1-16
	Thickness.....	L	3-16	3-16	3-16	7-32	1-4	9-32	5-16	11-32	3-8
	Internal Depth.	M	3	3	3 1-4	3 1-2	3 1-2	4	4	4 1-4	4 1-4
	Radius.....	P	1-2	1-2	1-2	5-8	5-8	3-4	3-4	7-8	7-8
	Diam. of Beads.	Q	5 3-8	5 7-8	6 3-8	7 5-8	8 7-8	10 1-16	11 3-8	12 1-2	14 13-16
	Width of Beads.	R	3-16	3-16	3-16	7-32	1-4	9-32	5-16	5-18	3-8
	Distance Between Beads.	T	1 1-2	1 7-16	1 5-8	1 13-16	1 3-4	2 1-16	2	2 3-16	2 1-8
	Distance of Bead from End.	U	1-4	1-4	1-4	1-4	1-4	5-16	5-16	5-16	5-16

WEIGHT OF PIPE

Overall Length, Feet.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
3	18	20	25	34	45½	59	76	94	128
6	33	36	46	63	86	112	144	176	245

committee to the main committee, and that nothing can be taken as conclusive until these recommendations have been submitted and approved by the main committee, which body has full control over all standards, and may approve or not, as it sees fit.

MARKING OR "STANDARD BRAND"

It is hoped that arrangements will be made for all pipes and fittings made to the "Standard Specification" to be stamped with a special mark or brand, to indicate to the purchaser that he is buying "standard goods," though at present there appear to be legal difficulties which prevent this being done, for it would appear that as the Registration Laws stands at present, if the "Standard Committee" issued a brand to be used by manufacturers on the goods they produced, the onus of seeing that the articles branded were really made to the standard specification, would fall on the shoulders of the committee, and this would entail the employment of an army of inspectors. The organization and expense of this arrangement would, of course, be enormous, and quite out of the range of "practical politics," unless it were in the hands of the Government, which, I am sure, few of us would wish to see.

I feel that you will agree with me in thinking that it is most desirable that something in the way of branding should be done.

Annual Meeting of English Heating Engineers

The British Institution of Heating and Ventilating Engineers held its annual meeting at the quarters of the Institute of Mechanical Engineers, Storey's Gate, St. James Park, London, England, on Thursday, February 19 last. Two papers were on the program: "Standardization of Cast Iron Pipes," by Louis F. Pearson, and "Ventilation of the House of Commons," by Walter Yates.

TABLE 4.—PROPOSED BRITISH STANDARD SMOKE PIPE BENDS

			Ins. 4	Ins. 4 1-2	Ins. 5	Ins. 6	Ins. 7	Ins. 8	Ins. 9	Ins. 10	Ins. 12
PIPE.	Internal Diam..	A									
	External Diam.	B	4 1-4	4 3-4	5 1-4	6 5-16	7 3-8	8 7-16	9 1-2	10 9-16	12 5-8
	Thickness of Metal.....	G	1-8	1-8	1-8	5-32	3-16	7-32	1-4	9-32	5-16
SOCKETS.	Internal Diam..	I	4 5-8	5 1-8	5 5-8	6 3-4	7 13-16	8 15-16	10 1-8	11 1-4	13 5-16
	External Diam.	J	5	5 1-2	6	7 3-16	8 5-16	9 1-2	10 3-4	11 7-8	14 1-16
	Depth.....	P	3	3	3 1-4	3 1-2	3 1-2	4	4	4 1-4	4 1-4
	Thickness.....	T	3-16	3-16	3-16	7-32	1-4	9-32	5-16	5-16	3-8
	Radius of Socket	R	3-8	3-8	3-8	7-16	1-2	9-16	5-8	11-16	3-4
	Radius of Bend	R1	1 1-2	1 1-2	1 1-2	1 5-8	1 3-4	1 7-8	2	2 1-8	2 1-4
	Radius of Centre Line.....	R2	3 5-8	3 7-8	4 1-8	4 3-4	5 1-2	6 1-8	6 3-4	7 3-8	8 9-16
BRANCHES	Spigot Branch..	S	5 3-8	5 5-8	5 7-8	6 1-4	6 1-2	6 7-8	7 1-4	7 5-8	8 7-16
	Socket Branch P & R=	SS	3 3-8	3 3-8	3 5-8	3 15-16	4	4 9-16	4 5-8	4 15-16	5
	Socket to Centre Line SS & R.=	U	7	7 1-4	7 3-4	8 3-4	9 7-16	10 5-8	11 3-8	12 3-8	13 9-16
	Spigot to Centre Line S & R2 =	W	9	9 1-2	10	11	12	13	14	15	17

Heating Systems for Railway Cars*

By Professor R. C. Carpenter

The heating of railway cars is a subject which has not received attention in the various meetings of this society. I do not propose in the present paper to criticise any of the present methods which are in use, or to suggest improvements, no matter how badly they may be needed, but will give a short sketch in a general way, of the various systems which have been, and are, in use for heating railway cars, with the hope that it will lead to a discussion which will bring out many structural details and matters of importance which should be preserved in the records of our society.

The American railway coach for passenger service is generally a long structure consisting of a single room mounted on wheels; its dimensions varying in length from 60 to 70 feet, its width from 8 to 9.5 feet and its height from 6 to 9 feet. The coach must be amply supplied with windows, and its structure is generally such as to expose a great deal of radiating and conducting surface, both of glass and of thin wall, and the motion of the car through the air produces the same effect in removing the heat as a strong wind striking against a stationary structure. The conditions relating to its use are essentially different from those relating to fixed habitations; the system of construction employed in its erection is different from that of houses, and, as a consequence, the coefficients which must be employed in computing the amount of radiating surface are likely to be different from those we are accustomed to use in proportioning the radiating surfaces in fixed structures.

*Paper read before the American Society of Heating and Ventilating Engineers, New York, January 22-24, 1907.

HEATING WITH STOVES

Previous to 1870 the passenger cars were quite generally warmed by stoves, one of which was located at each end of the car. These stoves were generally of a special pattern and designed with doors that were supposed to remain closed even if the car should be overturned, but, as a matter of fact, they did not do so, and the stoves proved both inefficient and dangerous in car heating.

HOT WATER HEATING

The inefficient results in the distribution of heat in various portions of the car led very early to the design of a heating system with extended radiating surface, which would transfer the heat equally to all portions of the car. The system which met with the most success for distributing the heat employed hot water and was patented by William G. Baker, March 10, 1868. This system was extensively used and at date of 1880 was in almost universal use for the purpose of heating railway cars.

The Baker hot water heating system differs materially from that employed in the heating of buildings in the arrangement of the heating surface with respect to the furnace, and in its general mode of operation. The Baker hot water heater, of necessity, had its grate and heating surface on a higher level than the radiating surface in the car, this being necessary because the radiating surface, in order to be out of the way and be efficient, must be arranged close to the floor. This practically cuts off all opportunity for obtaining a head for produc-

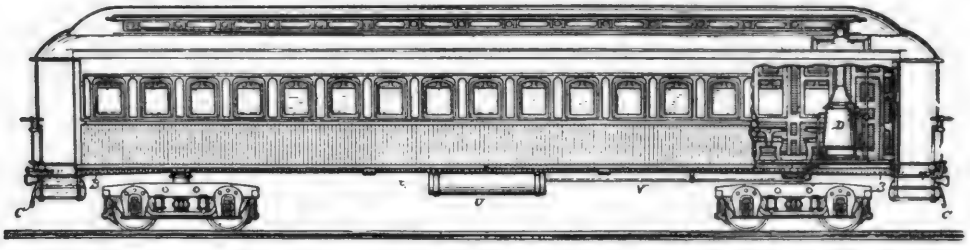
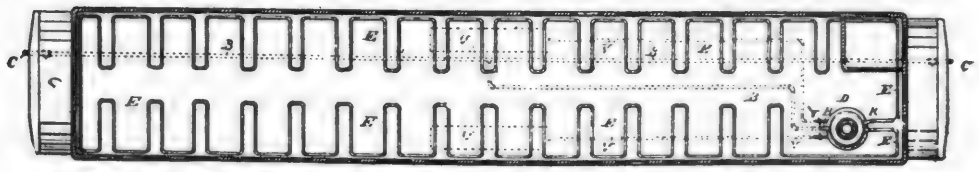


Fig. 2.



FIGS. 1 AND 2—PLAN AND ELEVATION OF THE BAKER HOT WATER SYSTEM AS APPLIED TO A RAILWAY CAR

ing gravity circulation, such as we obtain in stationary structures by the arrangement of the radiating surface some distance vertically above the heating surface in the heater.

system as applied to a car. An examination of the drawing shows the hot water heater located at *D*, and the piping arranged to extend under every seat. The system is better shown in Fig. 3, which

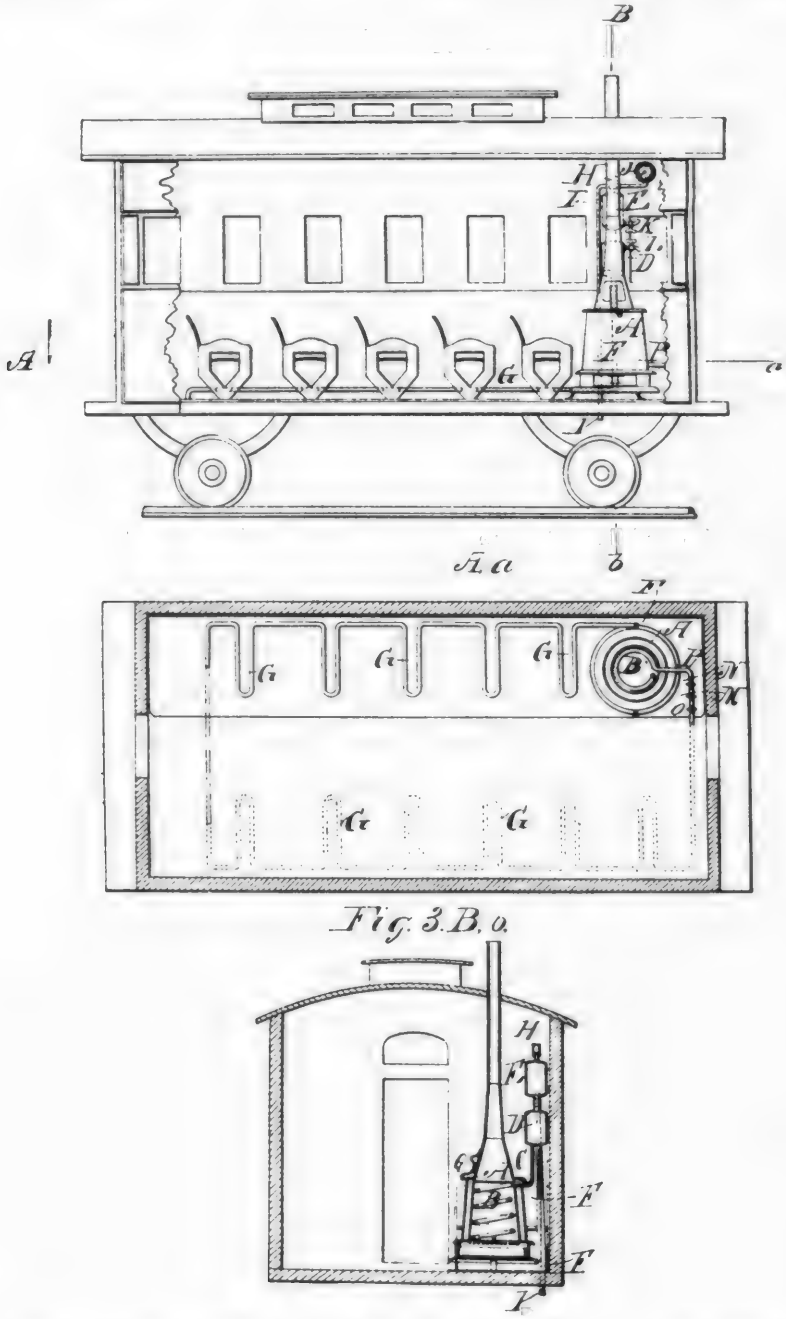


FIG. 3—BAKER SYSTEM OF HOT WATER HEATING AS ILLUSTRATED IN ORIGINAL PATENT PAPER

BAKER HOT WATER SYSTEM

This will be evident from an examination of Figs. 1 and 2 which give the plan and elevation of the Baker hot water

is reproduced from the Baker patent. The heater, *A*, consists of a coil, *B*, arranged so that the cooler water enters at the bottom and the heated water and

steam are discharged from the top through the pipe, *C*.

In the structure shown in the patent the flow takes place into a reservoir, *D*, which is connected by a pipe with an expansion chamber, *E*, which latter is provided with a safety valve, *H*, which opens in case of an excess of pressure. From the reservoir, *D*, the downward circulation takes place through the pipe, *F*, into the radiating surface, *G*, which latter is partly on one side of the car and partly on the other. The whole radiating surface, as shown, is a single pipe construction through which the entire water in the system must circulate A gauge for showing the pressure was applied to the system and also cocks for filling and draining.

In practice the system was somewhat modified, the closed expansion tank being located above the roof of the car in any position where the accidental discharge would not fall into the car. The lower reservoir was reduced to a fitting which connected the flow and return pipes together, but in all essential matters the structure employed was essentially that which is shown in the Baker patent, Fig. 3, although in practice the proportions were much modified.

A consideration of this structure serves to show that there is absolutely no gravity circulating head and no force which will cause circulation to exist throughout the system due to the different weights in the ascending and descending columns; on the contrary, a calculation will show that there is apparently a tendency, so far as producing circulation by gravity is concerned, for the water to move downward through the heater rather than in the proper direction.

This fact was pointed out in a paper read before the Western Railway Club of Chicago, in May, 1895, by James F. McElroy, consulting engineer for the Consolidated Car Heating System. It is a well-known fact, however, that the Baker hot water system did successfully maintain a circulation in the reverse direction from that which would be produced by gravity, which was due to the

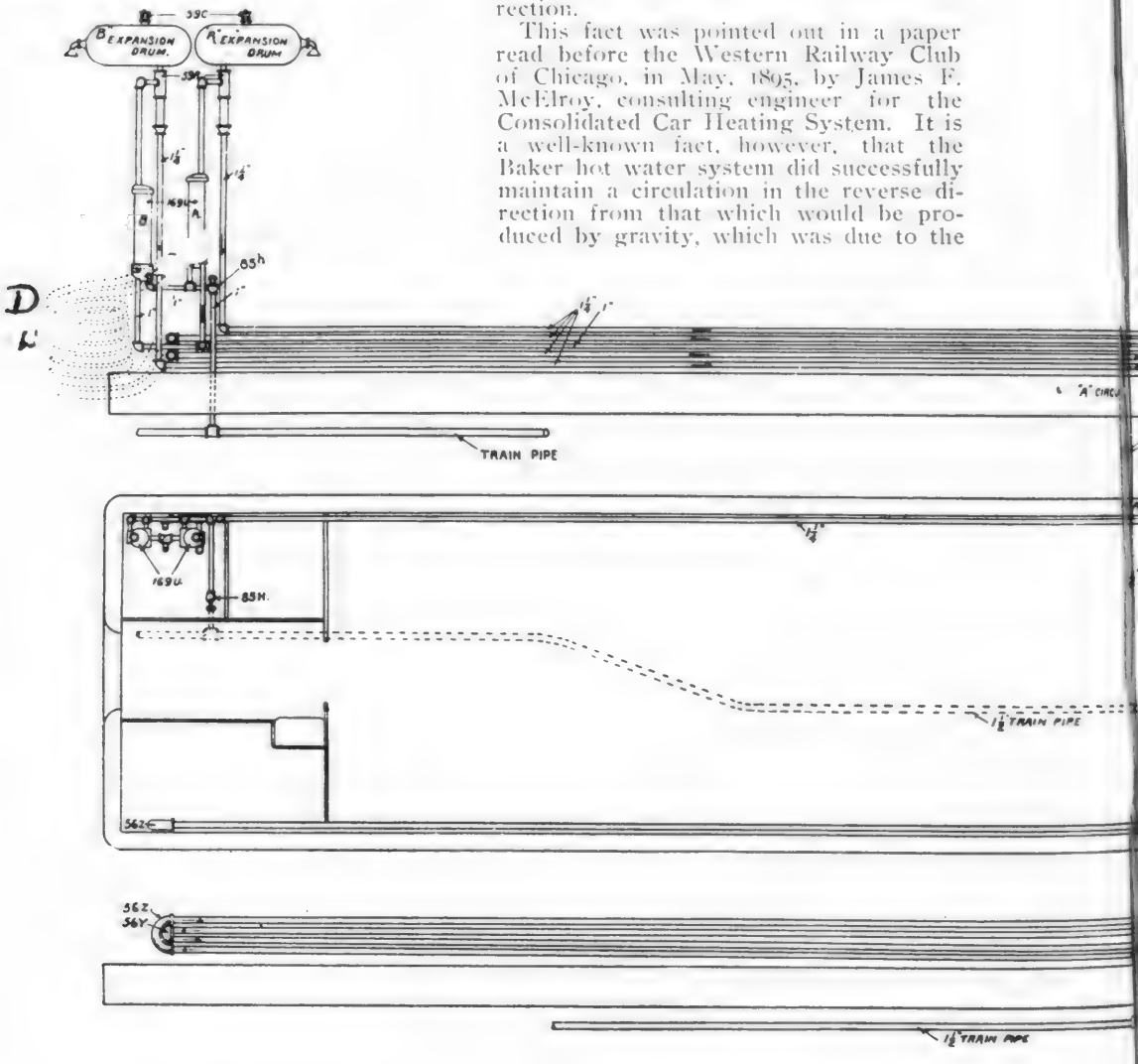


FIG. 5—PLAN OF PIPING PASSENGER

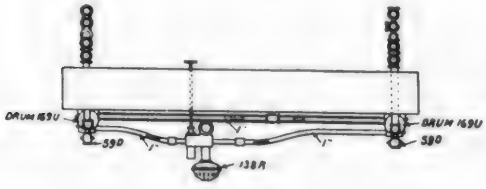
formation of steam bubbles in the coil and heater, and to the elastic force of the steam generated. The steam bubbles reduced the weight in the ascending column, passing through the heater, and also tended to act by their elastic force, thus causing a positive and rapid circulation. The circulation due to this cause is of an intermittent nature due to the alternate formation and condensation of the bubbles. The circulation produced, however, is positive and the force exerted in the formation of bubbles is sufficient to make an effective circulation even though the radiating surface is below that of the heating surface in the heater.

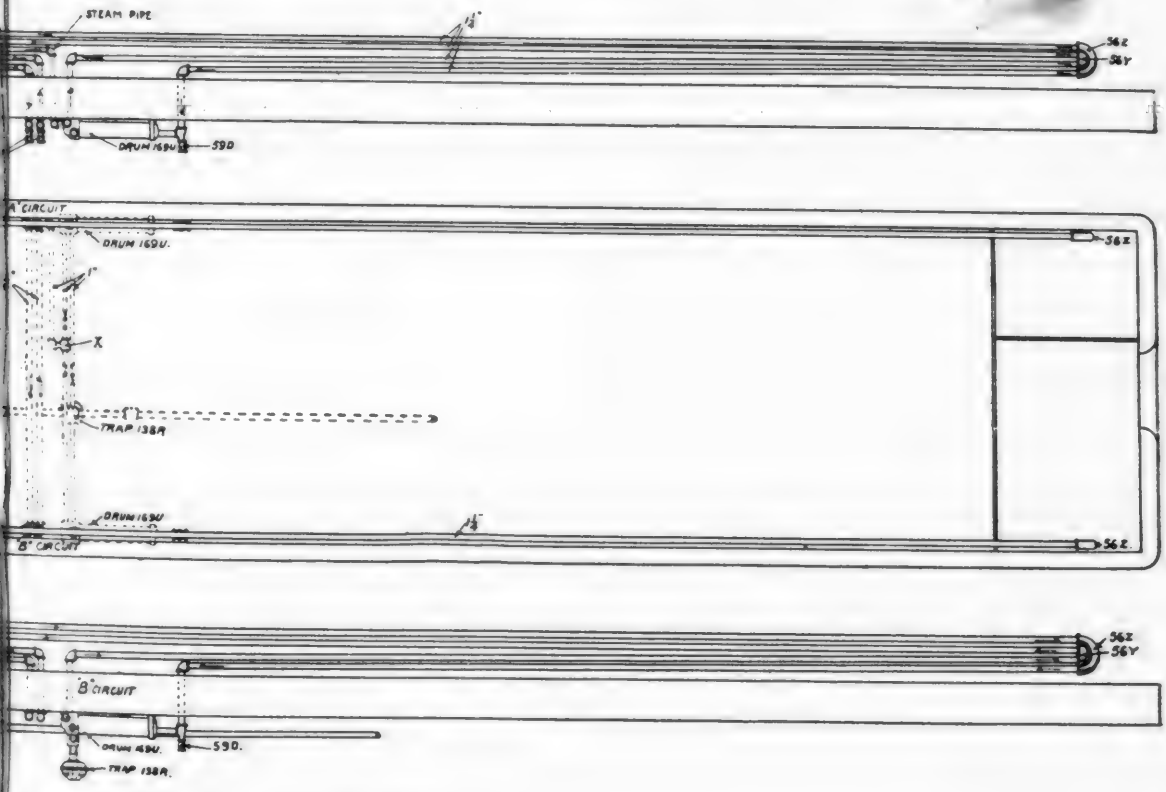
HOT WATER SYSTEMS HEATED BY STEAM

The Baker system of hot water heating was successful so far as the distribution of heat to the various portions of the car is concerned, but it was open to the serious objection of requiring an open fire in each and every car of the train. To satisfactorily care for these various fires required much labor, and the passengers were subject to considerable inconvenience from the coal dust and the work of attending the fires, which work was often very inefficiently done. The principal objection, however, was the added danger in case of an accident, due to the numerous open fires on the train, which was especially emphasized by the accidents at Angola, 1867, at Revere, 1871; Prospect, 1872; Richmond Switch, 1873, and Ashtabula, in 1876, where the fire from the heaters greatly increased and aggravated the horrors due to the railway accidents.

These accidents called public attention to the dangers of keeping open fires in railroad cars and led to a public demand for a system of heating with steam from the locomotive. In some states, laws were passed requiring all trains to be heated after a certain time in this manner.

As the cars were generally equipped with the Baker hot water heating system, nearly all of the first successful installations embodied the use of steam as a primary source of heat to warm the hot water in the Baker heating system. This system also presented the advantage of affording means for warming the car





R FOR OREGON SHORT LINE RAILROAD

in case it were detached from the train by maintaining a fire in the Baker heater, which latter was and is a matter of considerable practical importance.

FIRST USE OF STEAM FROM LOCOMOTIVES

About 1880 numerous patents were taken out for warming the water in the various hot water heater systems of the cars, by steam taken from the locomotive. The problems involved in this case, which were new and had to be practically solved before the systems could operate successfully, were, first, the development of a coupler for connecting the various cars which made up a train, which, of necessity, should have the features of flexibility, tightness, strength, interchangeability, and facility of coupling and uncoupling. The production of a suitable coupler was a problem which required considerable time to work out, the difficulties being much increased by the fact that the cars were interchanged from one railroad system to another, which practice made necessary a standard form throughout the country to meet the demands of interchangeability.

STEAM COUPLERS FOR CARS

The Sewall, Gold and Westinghouse couplers proved successful, and were extensively used on different systems. At the present time the Gold coupler is the one almost universally used. The cut, Fig. 4, shows the forms of most of the successful couplers which have been used in the heating of railway cars. An experience in heating railroad cars led to the use of flexible hose of short length for connecting the steam pipe of one car with that of the adjacent car.

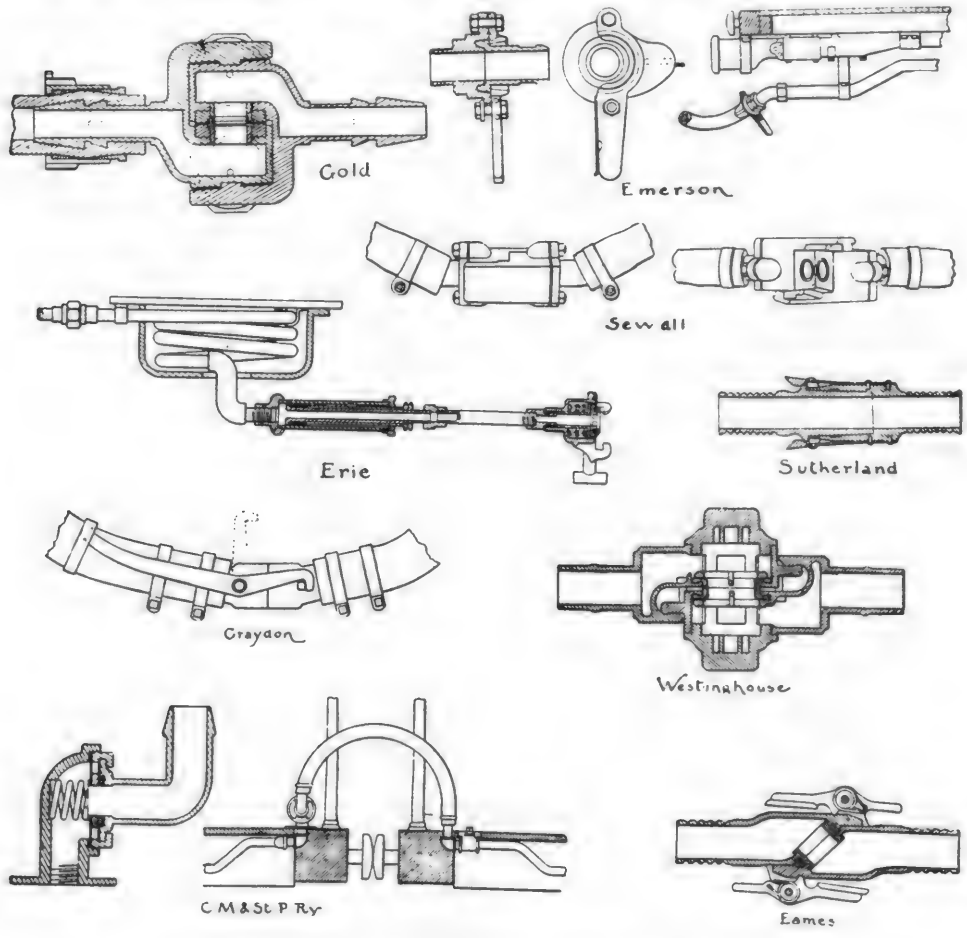


FIG. 4—COUPLINGS FOR STEAM CAR HEATING SYSTEMS

The second problem of importance which needed to be solved was that of producing circulation in the hot water heating system of each individual car, effectively and noiselessly, with the steam from the locomotive, substituted for the fire in the Baker stove. In order to solve the problem of circulation numerous inventions were brought forward which generally related to the location of the steam heater with reference to the circulating pipes of the hot water heating system.

EQUIPMENT OF CARS WITH BAKER SYSTEM AS AN AUXILIARY

It was generally required that the heating system should be applicable to the Baker fire heating system, which latter was to be maintained in condition for use when steam from the locomotive was not available.

The records of the U. S. Patent Office show numerous schemes for heating the water in the Baker hot water system with steam taken from the locomotive. These patents show various forms of steam heaters, in some of which the water circulated in a coil through the steam drum, but the preferred form was generally that in which the steam circulated in a coil through the surrounding body of water in a drum.

In one successful form of heater the steam was contained in a series of discs connected together, which were surrounded by the hot water to be warmed. The steam pipes were in all cases provided with a drip for removing the water of condensation; various schemes were proposed for controlling the discharge from this drip, and traps of various forms, as well as plain orifices regulated by hand, were shown and employed. A successful device of this character appears to have been a plain orifice controlled by a valve regulated by hand, which was steam jacketed so as to prevent freezing of the discharge in extremely cold weather, although a thermostatic steam trap is extensively employed.

The character of attendance on railroad trains has never been such as to render delicate automatic devices reliable. It has been proven from experience that better results were obtained usually when the care of the heating apparatus, such as the turning on of the heat or the draining of the heating pipes, was made a part of the simple routine duties of the attendant, who on the American railroads has the position of "brakeman." It may be remarked here, that the steam trap in use for draining the steam heater on the railroads is likely to be disarranged and give poor service because of the varying pressures of steam likely to come upon it and of the jarring incidental to its position on the car.

ARRANGEMENT OF CROSS OVER AT MIDDLE OF CAR

The hot water heating system as designed by Baker was a single pipe circulation system, the water passing from the heater through the pipe coils on one side of the car, then crossing over to the other side and passing through the coils on that side and thence back to the heater. In order to equalize the circulation on both sides of the car, the plan of arranging the cross over at the middle of the car has been frequently adopted when the water is heated by steam.

By this arrangement the hot water circulation is carried, first to the rear end of the car on the side of the heater, thence back to the center, whence it crosses over and circulates on the side of the car opposite the heater; thence crossing over near the center, it circulates on the side of the car at the end nearest the heater. In many cases each side is heated separately, and two independent circulating systems are used, as in Fig. 5.

The location of the steam heater, which is to supply steam heat in place of the Baker stove, is a matter of considerable importance in order that the same system of circulation may apply with either the steam heater or the stove in use. The patents which have been granted show numerous schemes for the location of heaters. They have been successfully used when located above or below the Baker heater and in series or in a multiple circuit with it. Practical as well as theoretical considerations indicated that the best results were obtained when two steam heaters were used, both of which were in series in the same circuit with the Baker heater, one located in the same riser pipe as the Baker heater, and the other underneath the floor of the car. With the latter system the upper heater tends to produce a forced circulation by the formation of steam bubbles, whereas the lower heater tends, because of its location, to supplement the circulation produced by the upper heater by gravity effects. Both heaters are useful in warming the circulating hot water.

Fig. 5 represents a heating system of this character as applied by the Consolidated Car Heating Company for the heating of the hot water heating system of a car. In this drawing, the coils of the Baker heater are shown as double and by dotted lines at *D*; the pipe supplying steam is marked train pipe.

In this system there are two circulating circuits, which are denoted on the drawings as the "A" circuit and the "B" circuit. Each circuit has a coil through the stove heater and an upper steam drum denoted for the "A" circuit by A, and for the "B" circuit by B, and an expansion drum provided with a safety valve and a filling cock; it also has a system of circulating pipe, and a steam drum or heater located beneath the car, marked 169 U. The arrows on the drawings show the direction of circulation.

It will be noted that the A circuit is arranged to warm one side of the car and the B circuit the other side, and that the cross-over pipes are located beneath the car. The water of condensation from the entire system of steam heaters is discharged through a single thermostatic trap, with a blow off regulated by a hand valve shown at 138 R.

THE COMMINGLER SYSTEM

An interesting construction known as the "commingler" system was patented by J. F. McElroy in 1890 and was used in the early 90's quite extensively for warming cars. The general characteristics of this system are shown in Fig. 6. Its principal characteristic consists in the use of a commingler chamber shown in section at large size at the right. In this commingler chamber the steam enters the water and is condensed therein, both heating the water and forcing a circulation. As shown in the drawing, the commingler is located at B in series with the coil through the Baker heater. The steam is taken from the locomotive through a train pipe shown in dotted lines. This method of heating increases the total water in the circulating system by the amount of steam condensed and for that reason it was provided with an overflow pipe shown at *H*, to discharge the excess water.

The commingler discharged the steam into the water in numerous small jets, through a body of pebbles, and in that manner effected the commingling of the steam and water noiselessly. The temperature of the car could, in a large measure, be controlled in this system by adjusting the admission valve, *C*, since it had the effect of controlling, in a large measure, the rate of circulation.

The hot water heating systems are still used extensively and present practice does not indicate any material changes. Nearly all the Pullman cars are heated with hot water substantially as shown in Figs. 1 and 5.

HEATING OF RAILWAY CARS WITH STEAM

At the present time nearly all of the railway day coaches are heated directly with live steam taken from the locomotive, and no provision is made for heating the cars independently with stoves or fire. In connection with this system it has generally been found necessary to provide means for supplying cars with steam when they are standing for some time in large yards and are not connected to the locomotive.

The steam heating systems in use consist of train pipes extending underneath the cars and provided with flexible couplings between the cars which are interchangeable with different cars and which are substantially of the form already described. The steam pipe is connected to the radiating surface in the cars by branch pipes underneath the center of the car, the radiating surface being drained by an orifice which is jacketed or kept warm by the heat of the steam, which is in a large measure controlled by hand or a trap. The main train pipe is dripped or drained at the end of the train.

The heating of cars with hot water circulation by steam is very largely done by special companies, of which business the Consolidated Car Heating Co., of Albany, N. Y., and the Safety Car Heating & Lighting Co., of New York, do the greater portion, at least of designing and providing pipe and fittings ready for installation. On the other hand, the installation of steam heating apparatus is principally done by the car builders as directed by the railroad company concerned.

The heating of railway cars by steam from the locomotive was proposed in the very earliest days of railroading, and is said to have been tried as early as 1851 on the Old Colony Railroad and in Germany as early as 1860. It was put into practical use in Germany as early as 1870, but did not prove successful and was abandoned.

It was not employed in this country until numerous accidents had aroused the sentiment of the people to such an extent that railroads were forced to take some step looking to the abolishment of stove heaters. In its practical use it has followed in railroad car heating the hot water heating systems which have already been described, so although it is the simplest method of car heating, it is also the most recent.

The system of steam heating in use is a pressure system employing live steam. In view of the fact that engines used on locomotives are non-condensing and discharge a great amount of exhaust steam, it would seem, in view of our experience with systems of exhaust steam heating for buildings, that the railroad systems presented great opportunities for economizing in this respect. Systems of exhaust steam heating were tried very early for heating railroad cars, but they have never been adopted to any great extent and can scarcely be said to be recognized or even known in the art.

A suction system employing a vacuum pump on the return pipe was at one time tried on the Central Railroad of Vermont. Other similar systems have been tried but without practical success.

The various methods of steam heating for railway cars which have been tried cover practically all those known in the art. It is unnecessary to discuss them at length as the methods involved are not different in general principles of construction from those commonly used in house heating.

THERMOSTATIC CONTROL

The automatic control of the temperature of railway cars has not been generally attempted; it has been employed, so far as I can ascertain, only in the case of a few special trains. I am not certain whether the attempts at thermostatic control have proved, from the railroad standpoint, a practical success or not, or whether its use is likely to increase or be abandoned. The regulation

of the temperature of cars by the attendants is generally erratic, and gives results which are far from satisfactory to the passengers. For this reason the efforts in this direction, if successful, will be highly appreciated by the traveling public. In view of the slow adoption of improvements of this character in the past, it seems probable that very much pressure will have to be applied to railroad companies before such improvements will be generally adopted. The manufacturers must first prove that their devices are practical and operative, and then they must stimulate a demand, otherwise they are quite certain to be neglected.

VENTILATION SYSTEMS

Our railroad cars are practically without any systems of ventilation. It is true that the cars are built with windows and doors which can be opened or closed, which provide communication with the external air. Any person who has had to spend much time in our railroad cars is painfully aware of the lack of ventilation. In this respect matters are worse than those relating to a thermostatic control, because, so far as I have been able to ascertain, no practical system of ventilation adapted for railway cars, has yet been worked out and its efficiency proved by actual successful trial. Until this is done, it is useless to urge improvements respecting ventilation upon the railroad companies.

I do not see any immediate chance for improvement along the lines of ventilation for this reason and it seems probable that for years to come such ventilation as is obtained on a railroad car must be had by the opening of windows or doors and by such service as is given at the present time by the brakeman or other attendant.

RADIATING SURFACE REQUIRED

The average passenger coach 60 feet long, when heated with hot water, is usually provided with 235 feet of 1¼-inch pipe radiation on each side. This is equivalent to 470 feet of 1¼-inch pipe for that entire car or 205 square feet of radiation. This amount is increased by an exposed steam heater and a little additional surface, probably amounting to 20 additional square feet, making a total for the car of about 225 square feet of radiation.

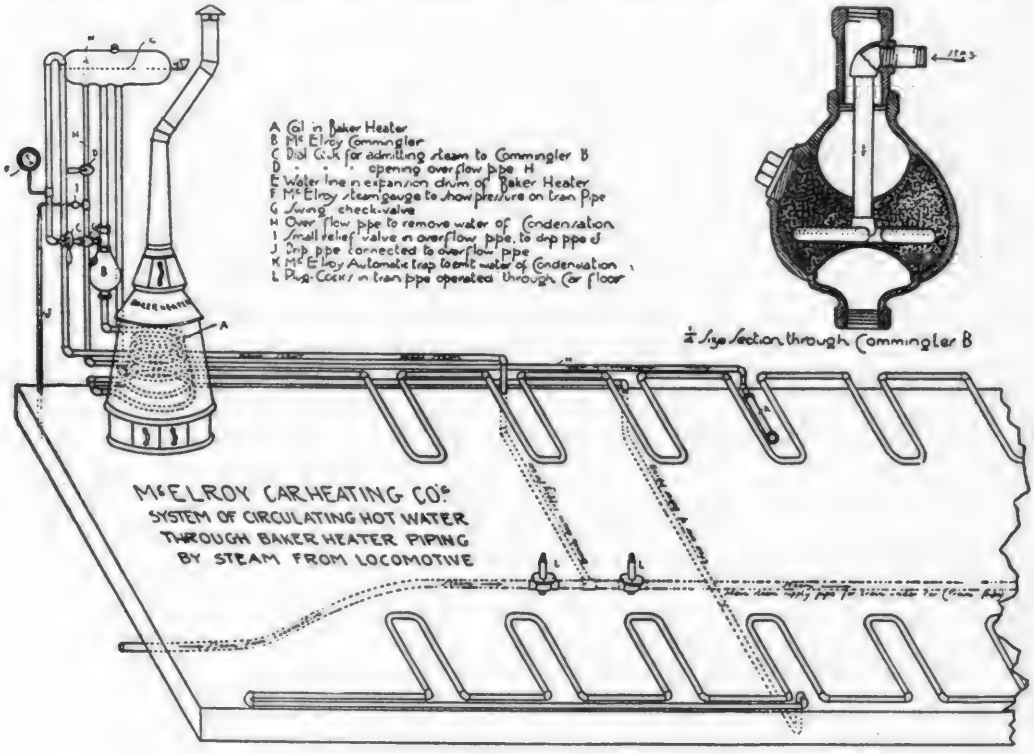

A Coil in Baker Heater
B Mc Elroy Commingler
C Dial Cock for admitting steam to Commingler B
D " " opening overflow pipe H
E Water line in expansion drum of Baker Heater
F Mc Elroy steam gauge to show pressure on train pipe
G Swing check-valve
H Over flow pipe to remove water of Condensation
I Small relief valve in overflow pipe, to drip pipe J
J Drip pipe connected to overflow pipe
K Mc Elroy Automatic trap to emit water of Condensation
L Plug Cocks in train pipe operated through car floor
½ Size Section through Commingler B
McELROY CARHEATING CO'S
SYSTEM OF CIRCULATING HOT WATER
THROUGH BAKER HEATER PIPING
BY STEAM FROM LOCOMOTIVE

FIG. 6—THE COMMINGLER SYSTEM

The temperature of the hot water in the pressure systems of circulation employed in car heating, can be considered as fully equal to that of steam in a low pressure heating system.

It is interesting to compare the amount provided in car heating with the amount that would ordinarily be used in a building of the same exposure. For average values of coefficients for heat transmission and for a temperature outside of

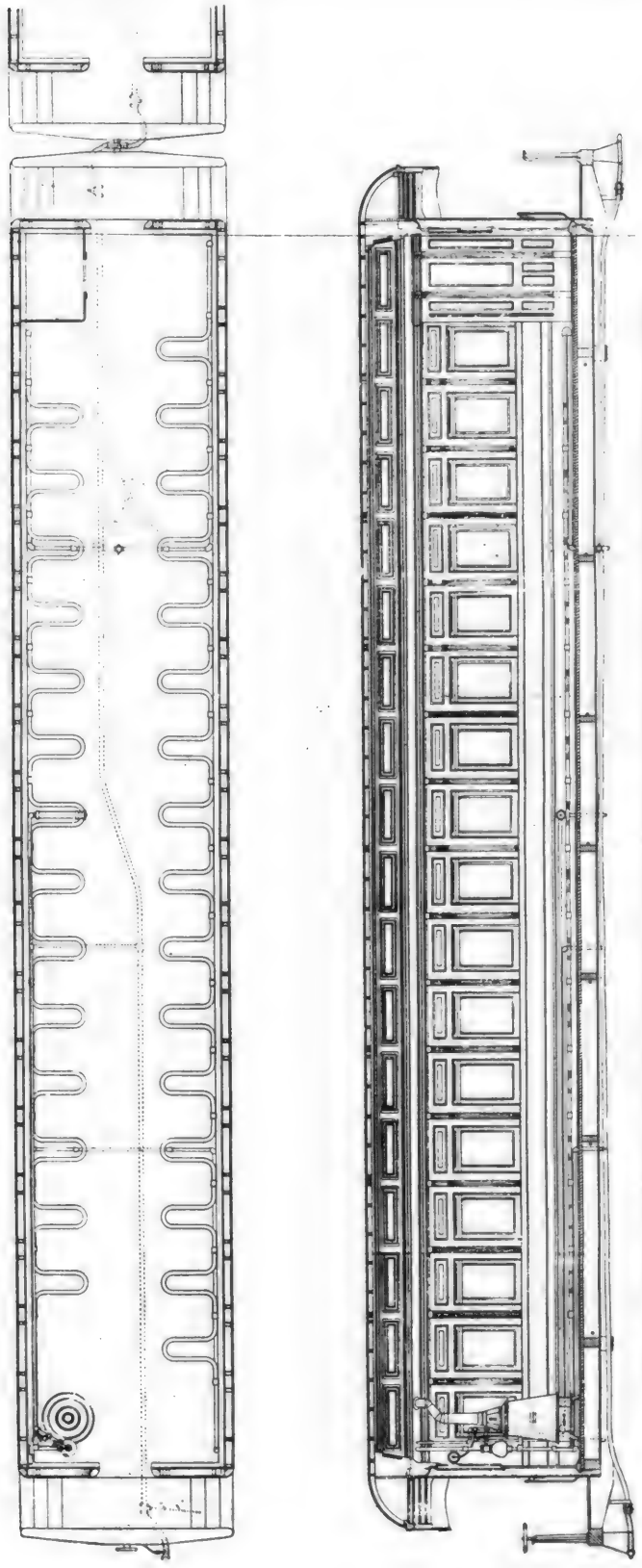


FIG. 7—SECTION AND PLAN OF CAR WITH HOT WATER SYSTEM HEATED EITHER BY STEAM OR FIRE

zero and inside of 70 degrees F., the following formula for the amount of radiation is found satisfactory:

$$R = \tfrac{1}{4}(G - G' + \tfrac{nc}{50}) - \tfrac{1}{4}(G + G' + G'')$$

in which R = sq. ft. of radiation.
G = exposed glass surface sq. ft.
G' = wall surface exposed as equivalent glass sq. ft. surface.
g = cubic contents in cu. ft.
h = number of changes of air per hour.
G'' = glass surface equivalent in heat loss to change of air in car.

Under ordinary conditions 4 sq. ft. of exposed wall surface is equivalent to 1 of glass surface, and this relation, I believe, will hold for the sides and roof of the car. The floor of a car is built much warmer than the sides, and is less exposed. I consider its value in equivalent glass surface as only one-third of that of the walls, which for the sake of obtaining a basis of computation, I do not believe is greatly in error. The ends of a car are less exposed than the side walls, and I have assumed the value in equivalent glass surface as one-half of that of the side walls. The change of air per hour will depend very much upon conditions, but I have assumed, as an average case, that it will change twice or n=2.

Assuming the car as 9 feet wide, 6 feet high at the sides, 9 feet in the center, and 60 feet long, the following table gives the various elements required for computing the heating surface needed.

The cubic contents will be essentially 60x9x8=4,320 cu. ft.

	Dimensions	Table Sq. ft.	Factor	Equivalent Glass surface	Formula Values
Side windows	120x3	360	1	360	G
Top windows	120x5	60	1	60	
Side walls	120x3	360	1-4	90	
Roof	60x9	540	1-4	135	G feet
Floor	60x9	540	1–12	45	
Ends	18x9	162	1–8	20	
Cu. ft. air per hour	60x9x9=2	9720	1–50	194	G inches
Total				904	

Substituting the values as above in the formula $R=\tfrac{1}{4}(894)=223$ sq. ft. from which it would seem that under the ordinary rules for heating a building, a car of the dimensions stated would require 223 square feet of low pressure steam heating surface.

The above calculation indicates that the practice of supplying radiating surface for heating railroad cars is not essentially different from that used in heating buildings and the same rules for proportioning surface may be applied.

The object of this paper has been to give you a bird's eye view of the various systems of railroad car heating which have been and are in use, with the hope that it will lead to a discussion which will bring out matters of practical value, not only to ourselves, but to those interested in railway construction and operation.

The paper has of necessity been rather long and devoted only to general statements and discussions of processes and methods of operation rather than to details of construction.

American Heating Apparatus for Foreign Markets

In an article addressed primarily to the foreign importer, the *New York Commercial* has the following to say in regard to heating and the superiority of American heating goods:

It has been estimated that a ton of coal will warm 1,200 cubic feet of air from zero to 70 degrees by the furnace system, 1,600 cubic feet by steam, and 1,800 feet by the hot water system, and these proportions indicate fairly well the amount of saving in fuel that steam and hot water offer as compared with the furnace. In the case of a large building the saving would easily be sufficient in a few years to pay for the entire cost of the apparatus. The boilers at present manufactured for heating both by steam and hot water systems by leading American manufacturers in this line are exceedingly efficient, occupy small space and do not easily get out of repair. They are much simpler to operate than most people imagine, while to the housekeeper either system means an immense improvement in point of cleanliness, since the rooms are free from dust and dirt such as are unavoidable with stoves and other types of hot air heaters.

In order to be equipped for every class of trade, the importer or general merchant who intends to handle American heating apparatus should provide himself with catalogues, etc., of some of the leading manufacturers of steam and hot water systems, as well as stoves and ranges. It might also be well to include blowers and ventilating apparatus in addition in case large modern buildings are likely to be erected, such as schoolhouses, office buildings, government buildings or other public edifices.

THE HEATING AND VENTILATING MAGAZINE

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BEFORE two recent meetings of the American Society of Heating and Ventilating Engineers, the question has been discussed at length as to who should guarantee the efficiency of a heating apparatus, the engineer who designs it or the contractor who installs it. Judging from the many varying expressions of opinion heard, the question is one that has two well-defined sides and is capable of working much hardship, looked at either way. It would seem, however, that it were possible of adjustment upon a legal basis, and, indeed, a number of legal decisions were cited to support the claim of the contractor that he should not be held responsible for the designing engineer's specifications.

At a recent meeting of refrigerating engineers, a lawyer, Mr. John C. Wait, discussed the legal aspect of the subject as it pertains to refrigerating work, and many of his remarks apply equally to the question as it presents itself to the heating engineer. Mr. Wait's views on the subject come at a most opportune time and will no doubt offer suggestions to many who may be called upon shortly to take a stand one way or the other upon the matter.

"IT is asking a good deal," says Mr. Wait, "of a manufacturer or engineer to warrant the efficiency or capacity of his design, but it is asking a great deal more when a manufacturer is asked to follow the plans and specifications of an architect or engineer; and especially when such plans and specifications have been prepared on a presumption that said architect or engineer knows the business, or when they have been prepared with the counsel and advice of some other manufacturer who has special devices and apparatus, which are designated and required to be used and which are adapted particularly to the plant or equipment of such manufacturer. Then it is that the warranty of results becomes a serious question.

"As regards a private owner and the manufacturer, it may be stated, as a general proposition of law, that when an owner prepares plans and specifications setting forth the general detailed manner in which the structure is to be built, he warrants the sufficiency of such plans and specifications.

"It seems unreasonable to allow an owner or his engineer or architect to arbitrarily specify details of a machine or structure, the character of the materials employed and the sizes and shapes of its parts, and to then impose the responsibility of its good behavior upon the manufacturer, and such a practice would appear to be extraordinary. It is, however, a frequent occurrence, if not a common practice, and it is not confined to the manufacture of machines. A heating contractor is required to warrant that the apparatus will heat the rooms of a building at 70° in zero weather, when the

boiler is already installed and its capacity fixed.

"Under such circumstances it is a puzzling situation and requires more than ordinary decision of character to determine whether one will bid or not, and having bid and been awarded the contract, whether he will bend to the will of the architect or pursue such a course as will enable him to fulfill the warranty. The situation is not, perhaps, so serious, when the work is being done for a private party as when done for a public corporation.

"The successful bidder may find himself tied up by specifications practically requiring a competitor's apparatus and an auxiliary warranty on his part that it shall fulfill and perform certain conditions as to capacity, efficiency and duty. In this case what shall he do? Shall he abandon the specifications and fulfill the warranty, or shall he fulfill the warranty and repudiate the specifications?

"It is my opinion that he has a good fighting chance to do either, especially on municipal work. He may defeat public officers in their attempts to hold up his payment or in their refusal to certify because he has not strictly followed the specifications, and if he has followed the specifications he may escape the warranty by showing that he has fulfilled and performed as required, and that the city or its agents warrant the sufficiency of their designs.

"Whether the owner or the contractor be liable upon the warranty or for the perfection of the work, or the efficiency or duty of the plant, it must be conceded that the practice of preparing specifications in detail and requiring the contractor to follow them, and to then extract a warranty as to the efficiency, duty or perfection, is a practice that should be condemned in engineering circles, and that no self-respecting engineer or architect will tie a contractor or manufacturer to detailed specifications and then require him to warrant the results. Such a practice should not be countenanced."

NO recent ruling of the Post Office Department has been of such direct interest to the manufacturers of the country as the order promulgated in November last prohibiting, after March 1, 1907, the use of coupons in advertisements in newspapers and magazines, when such coupons were designed to be signed, cut out and returned to the advertiser. It now appears that the order was without sufficient authority of law, an opinion having been rendered by a law officer of the Post Office Department which will permit of a modification of the ruling. It is announced, however, that certain limitations will be imposed in the use of advertising coupons, to be published shortly.

A STUDY of the weather charts presented in this issue would seem to show that the wind movement in New York City during February was greater than that of the other cities from which we receive reports. It should be explained that the hourly observations of the wind velocity, from which the charts are compiled, do not always mean that no higher velocities were recorded in the interim between the observations. In New York City, however, where we have access to the reports giving a continuous record of the wind movement, it is possible to indicate the actual velocities reached at every period of the day. This seeming discrepancy may be adjusted by referring to the total wind movement for the month as given in the data accompanying the charts.

The Derivation of Constants for Building Losses*

By Professor R. C. Carpenter

Prof. R. C. Carpenter

THERE has been noticeable progress in the last few years in the use of scientific formulas for designing heating and ventilating apparatus and this progress has been greatly helped by various scientific papers read before this society. In a few years, I believe, the "rule of thumb," now still used to a considerable extent, will entirely drop out of use and be replaced by scientific methods.

I believe that engineers in our work now generally recognize the fact that practically all phenomena relating to the transfer of heat fall under general laws of Nature which can be expressed by rational formulas. It is also recognized that in the application of such laws are formulas, "coefficients," connecting the theoretical with the practical case are necessary and must be applied. This paper deals with the origin of such coefficients as applied to determine the transfer of heat through walls and windows of buildings.

In the calculation of radiating surfaces and the various elements of our heating systems we employ certain constants. It is a matter of very great interest to ascertain how those constants were found and whether they rest on a scientific basis of measurement or merely depend upon the estimate of designers, in which case they frequently vary greatly from the truth.

The above statement might indicate that I was able to give you definite information as to the origin of many of these constants. I am sorry, however, to state that such is not the case. My object in presenting the paper is merely to call attention to the actual state of our knowledge, hoping that it will bring out, at later meetings if not at this one, the information desired.

At the August meeting of the society, Mr. Walter Jones, of Stourbridge, England, read a valuable paper entitled "Heat Losses and Heat Transmission," in which he compared the different coefficients for building losses as given by various authorities. This comparison indicated that the authorities differed greatly as to some coefficients but were in quite close agreement as to others.

*Paper read at the Thirteenth Annual Meeting of the American Society of Heating and Ventilating Engineers, New York, January 22-24, 1907.

All our coefficients originated from Peclet's experiments

Some years ago I tried to find what actual experiments had been made for determining these various coefficients. The result of this investigation indicated that practically all our coefficients for heat losses and heat transmissions resulted from experiments made by Peclet in France about 1860, and, further, that so far as I could ascertain, these were the only original experiments which completely covered the field. These experiments are described in Vol. I, Traité de la Chaleur, by Peclet (first edition, 1863; fourth edition, 1874).

I have published in the fourth edition of my work on "Heating and Ventilating," a translation of that portion of Peclet that relates to "Heat Transmission Through Radiators and Buildings." This I will append to my paper for convenience of reference.

Various authorities in different languages, in applying Peclet's experimental values to different conditions, have obtained slightly different results, partly due to difference in assumed conditions and partly due to the translation, and this in a large measure accounts for the difference in the various coefficients as given by different authorities.

There is no doubt that in some cases coefficients had been deduced from rules of practice or rules of thumb, but such coefficients have not generally been of a scientific form nor have they been widely used.

In the English work by Box on "Heat," numerous examples of the application of Peclet's coefficients are given. This work was published very early; it was the first English book to call attention to Peclet's experiments and is in a measure largely responsible for the coefficients which are used extensively by the English-speaking people.

Coefficients obtained by experimenting upon small sections of the building

Box and Peclet both present methods of computing building losses by applying the coefficients to small sections of the building. This method is an accurate one, but it seems to me, in view of the crudeness of the coefficients themselves, it is a refinement which is not warranted except for very large buildings. For that reason I advise the use of average values in computing the heat losses from walls and windows of buildings of ordinary or small size. My own opinion is that the average values, which can be readily and quickly applied, give fully as satisfactory results as the application of each

special coefficient to each special part of the building, and it saves a great amount of labor. For large buildings the more exact method is preferable, as suggested by Box and Peclet.

From my study of the Peclet experiments, which, I believe, are the scientific basis of the coefficients practically used by all our authorities, I do not believe that they have such a degree of accuracy as to warrant extending our computation results very far. To illustrate, if the Peclet experiments involve an error of 10 per cent., which I think is probable, and if these determine our coefficients, it is rather absurd and foolish to carry our calculations in applying these coefficients to ½ of 1 per cent.; yet this is a thing which all of us are very prone to do and we often imagine that because our figures are carried to small decimal places, our results are therefore very accurate.

RECKNAGEL'S AND REITSCHEL'S COEFFICIENTS DERIVED FROM PECLET

The coefficients which are given by Recknagel and Rietschel agree so closely with those derived from Peclet's experiments, that I believe they have the same origin as those which we have obtained from Box, which, we know, came from Peclet. This fact confirms me in the opinion that the scientific derivation of the principal coefficients used for heat losses from buildings is derived from Peclet's experiments.

Respecting the coefficients for heat transmission on radiating surfaces, a large number of experiments have been made in nearly every country. The coefficients derived from these experiments, however, agree so closely with those given by Peclet that for general cases those given by Peclet can be used with satisfactory results.

PECLET'S EXPERIMENTS SHOULD BE REPEATED ON LARGER SCALE

In view of the recent improvements in apparatus for measuring heat transfers and of the changes in building construction which have occurred during the last quarter century, it would certainly be desirable if the experiments made by Peclet could be repeated on a larger scale and with more accurate instruments. It is not, however, probable that if this were done the results would be essentially different from those obtained years ago by Peclet. We know that within certain practical limits Peclet's results are accurate, since the coefficients obtained from them when applied to modern heating systems give satisfactory results. In two cases I have had an opportunity of comparing the heat transmitted through the walls and windows of a building with the average of Peclet's results, and in both these cases the comparison checked up very closely.

EXPERIMENTS SHOWING GENERAL ACCURACY OF PECLET'S RESULTS

In the first case a room on the second floor with exposed side and end had 246 square feet of wall surface and 96 square feet of window surface. By experiment I found that when the air in the room was 28 degrees above that outside, 4,247 B. T. U. per hour was required to maintain a uniform temperature and represented the building losses; when 27 degrees above, 4,240 B. T. U. was required. *The average of Peclet's results indicate that 4 square feet of wall surface or 1 square foot of window surface transmits practically 1 B. T. U. per square foot per hour per degree difference of temperature.*

Applying this rule to the cases stated, the building loss for the first case should have been 4,410 and for the second case 4,253 B. T. U.

In the second case, a test of the New York State Veterinary College showed that to maintain the building 31 degrees warmer than the outside air, 16,000 B. T. U. were required per minute, of which 39 per cent. escaped in the ventilation flues and 61 per cent. passed by conduction through the walls and windows. The building was exposed on all sides, was three stories in height, had 9,280 square feet of glass and 31,644 square feet of exposed wall surface.

By the rule founded on Peclet's average results as above, the building loss should be 532,952 B. T. U. per hour. The actual loss by experiment by the building was 547,200 B. T. U. per hour, which is within 2 per cent. of that called for by the rule. In this case the building was of brick, thickness of walls 24 to 16 inches, the windows having single glass.

The above experiments, as well as those which are made by structures proportioned in accordance with the coefficients, indicate the substantial practical accuracy of the early experiments by Peclet, and show that we do not run any very great risk of making serious mistakes in applying them. It is quite probable that the variation in conditions as to materials or exposure, which are not considered in the average case, cause most of the errors in the application of these coefficients.

I am in hope that this short paper will bring out for our proceedings some additional information as to the origin of these coefficients and how nearly accurate they are found in practice.

At the annual meeting of the Association of Steam and Hot Water Heating Engineers of Milwaukee, Wis., the following officers were elected: President, Edmund Grassler; vice-president, Charles Fox; treasurer, Louis Griewisch; recording secretary, Louis A. Riemer; corresponding secretary, Oscar Wild; sergeant-at-arms, A. H. Wegner.

Ventilation of the Boston Subway*

DISCUSSION

MR. L. H. WOODBRIDGE (Continued)—It is of importance to note that the characteristic curve of the radial fan, whether cased or open, would show a minimum energy input to fan when no air is being moved through it and the system with which it is in connection, and an increasing energy input as the volume of air passed through the fan and system is increased; and, second, that with the axial fan the reverse is found to be true, since for any given speed the less effective work done by the fan the greater the energy input to the fan; the larger the effective work the less the energy input.

Because of the very small resisting pressure against which fans would operate to produce a slow flow of air through the subway as a conduit, and through vent ways from the fans, carefully designed for the purpose of reducing frictional and other resistance to a minimum, the choice of fans was narrowed down to the Briggs-Meigs radial, and the Blackman axial reversed. The subway construction, as well as the admissible dimensions of ventilating chambers, imposed a limit on the size of permissible fans.

A radial fan with generous inlet requires about the same wall aperture as that which an axial fan would fill. Thus a 30-inch axial fan fills about the same wall aperture as is required by a 36-inch Briggs-Meigs radial fan.

By reference to curves, from which the tables are made up, it appears that under a resistance pressure of 2/10 inch water column the radial fan moves 5,675 cubic feet per minute, as against 3,475 cubic feet by the axial reversed. Therefore, at that pressure, the speed of the axial fan would have to become 64 per cent. greater, or 820 r.p.m., to make its output equal to that of the radial; and as energy input to fans of given size varies as the cube of speeds, the power would be increased practically fivefold, and would become $0.34 \times 5 = 1.55$ horsepower for moving 5,675 cubic feet of air per minute, which would make the cubic foot work nine foot pounds as against five for the radial fan. Furthermore, the noise resulting from such high speed of the axial fan would prove a serious objection to its use. The action of the radial fan of the Briggs-Meigs type requiring the same wall aperture and moving the same air quantity would be unobjectionable.

MR. W. CLIFFORD.—Assuming the number of passengers at Park Street Station to be 90,000,000 per year, equal to 246,570 per day of 24 hours, or an average of 10,000 per hour, or, say, 30,000 during the busiest hour of the day, and assuming 100 cubic feet of air per passenger per minute diffused through the station, a ventilation of 50,000 feet per minute would be required at this point.

If the efficiency of ventilation alone is to be considered, placing an exhaust fan midway between two stations is a good arrangement, provided the volume produced is sufficiently large to maintain a velocity of current that will carry away the impalpable dust, or even the larger particles stirred up by the moving trains or ground off the tires of the wheels and the contact shoes of the third rail. A means of automatically increasing the speed of the fan to maintain the fixed normal volume (when increased resistance, through the piston action of meeting trains tends to diminish it) should also be provided.

This short Boston subway could easily be ventilated by one installation giving a high standard of mechanical efficiency, say 80 per cent. with an electric drive, and in case of a long subway like New York one installation could be used to cover ten miles of tunnel to a very great advantage. There can be no objection to high speed of ventilating current where there is already rapid movement of trains.

In ventilating mines the writer frequently recommends their laying out in such a way that the whole ventilating power of the fan can be directed through one split or division of a mine at once, when desired. This often means a current velocity of 60 miles an hour. One hour's application of this hurricane ventilation removes all dangerous dust and more effectually prevents explosions than weeks of expensive water sprinkling. Apart from the nature of the danger, the same principle holds good with a ventilating current of a tunnel.

MR. FRANCIS FOX.—As the Boston subway is worked electrically, the question of ventilation is greatly simplified, as compared with tunnels in which the products of combustion from steam locomotives have also to be considered.

Assuming 30 cubic feet per minute per person as the volume of air required to maintain purity, this being the standard we adopt, I arrive at the following results, which are necessarily only approximate, as I have not all the necessary data upon which to base the calculations.

I observe that the traffic in the first 12 months was 50,000,000 passengers, and these have increased in number 60 per cent., or 30,000,000, making a total for the year of 80,000,00. Assuming the traffic on Sundays to be one-half of that on ordinary week days, we take 340 full days for the year; this gives a daily traffic of 235,294. Assuming that one-fourth of this represents the crush hour traffic of one hour duration under the most congested conditions, we obtain 59,000, as the figure representing the maximum number of passengers passing through in one hour.

I have no data as to the average time each passenger is in the subway, but I assume it to be eight minutes; this gives 7,866 minute passengers to be provided

*A paper upon this subject, by Mr. H. A. Carson, was read at the December, 1906, meeting of the American Society of Mechanical Engineers.

with 30 cubic feet of air, or a total volume of air required of 235,980 cubic feet per minute.

From the paper I gather that the volume of air being exhausted from the tunnel, and which is therefore replaced by fresh air from outside is 292,000, thus showing that the purity of the air is all that can be desired.

In London we have certain electrical railways which are insufficiently ventilated, while on the other hand some are overventilated, insomuch that objectionable draughts are produced, which act as deterrents to some intending passengers.

A happy medium between over- and under-ventilation is what is required, combined with careful observation of the force and duration of the wind outside, and in the Boston subway this can evidently be attained.

The ventilating duct in the crown of the tunnel is a satisfactory arrangement in the case of electrical railways where soot has not to be contended with, and as it has a sectional area of 48 square feet for a volume of 45,000 cubic feet per minute, the velocity is not excessive.

As regards the cooling of the air in tunnels, we have found the greatest advantage in the adoption of fine spraying of water in the Simplon Tunnel. By this means the temperature of the air can easily be lowered by 20 to 30 degrees Fahr., or even more.

In conclusion, I am glad to find that the system of ventilation of the Mersey Tunnel, which was carried out in 1880-1886 (and was then described as drawing vitiated air from the tunnel at a point midway between the stations, and which has stood the test of 20 years of experience), has been applied to the Boston subway with so much skill and so much deserved success.

MR. WALTER B. SNOW.—The original paper and Professor Woodbridge's discussion refer to an air change once in ten minutes and to a flow of one linear foot per second from each station toward each center of discharge. The change of air is sufficient to meet all ordinary conditions, but such a low rate of flow (which is a measure of a vacuum produced) would leave any ventilating system practically powerless to overcome the effect of ordinary atmospheric changes. A difference of only .01 inch of water is sufficient to produce a velocity about six times greater than that planned for the subway. What must be the result when large open portals and numerous entrances and exits, to say nothing of moving trains, afford ample opportunity for the creation of pressure differences much greater than .01 inch? Under these conditions the fan becomes merely local in its effect. It is practically powerless to control the direction of currents at such distances as exist in the subway. In a word, so long as the subway connects through large openings with the outer atmosphere, it is impossible for the fans of the capacity here installed to properly control the flow of air. The trouble in the case of this installation is not with the fan, but with its size. The problem is one of volume and velocity, which must be sufficient to insure the maintenance of a pressure difference which cannot be overcome by atmospheric conditions.

The Weather During February

NEW YORK

In New York, the highest temperature recorded was 44 degrees on the 14th, and the lowest, 1 degree on the 12th. The greatest daily range was 29 degrees on the 11th, and the least daily range, 4 degrees on the 4th. The mean temperature for the month was 24 degrees, being 7 degrees below the average for this month for 37 years. There were 2.52 inches of rain and 20.7 inches of snow. The greatest amount of rain in any one day was 1.07 inches on the 4th-5th. At the end of the month there were 4.1 inches of snow. The prevailing direction of the wind was northwest and the total movement, 9,357 miles; average hourly velocity, 13.9 miles; maximum velocity for 5 minutes, 48 miles per hour from the west on the 3rd. There were 9 clear days, 11 partly cloudy, 8 cloudy and 8 rainy.

ST. LOUIS

In St. Louis, the highest temperature was 72 degrees on the 13th, and the lowest, 3 degrees on the 5th. The greatest daily range was 35 degrees on the 13th, and the least daily range, 4 degrees on the 24th. The mean temperature for the month was 34 degrees, being the same as that for the last 34 years. The total rainfall was 1.12 inches, and the snowfall, 7.9 inches. The greatest rainfall in any one day occurred on the 23rd, when 0.52 inches were recorded. At the end of the month there was no snow. The prevailing direction of the wind was northwest; total movement, 7,519 miles; average hourly velocity, 11.2 miles; maximum velocity for 5 minutes, 38 miles per hour from the northwest on the 2nd. There were 12 clear days, 4 partly cloudy, 12 cloudy and 10 rainy.

BOSTON

In Boston, the highest temperature recorded was 52 degrees on the 14th, and the lowest, 2 degrees below zero on the 23rd. The greatest daily range was 30 degrees on the 11th, and the least daily range, 6 degrees on the 4th. The mean temperature for the month was 22 degrees, being 5.9 degrees below the average for 37 years. The total rainfall for the month was 1.88 inches, and the snowfall, 25.6 inches. The greatest rainfall in any one day was 0.89 inches on the 4th-5th. At the end of the month there were 2.8 inches of snow. The prevailing di-

rection of the wind was west and the total movement, 7,884 miles; average hourly velocity, 11.7 miles; maximum velocity for 5 minutes, 35 miles per hour from the northwest on the 25th. There were 8 clear days, 6 partly cloudy, 14 cloudy and 13 rainy.

PITTSBURG

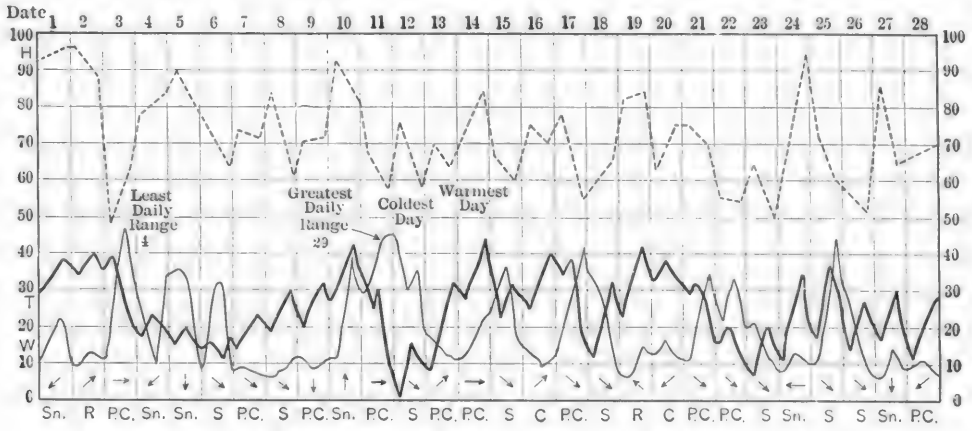
The highest temperature for the month was 54 degrees on the 14th, and the lowest, 3 degrees on the 12th. The greatest daily range was 37 degrees on the 14th, and the least daily range, 6 degrees on the 16th. The mean temperature for the month was 26 degrees, being 6 degrees below the average for 37 years. There were 0.74 inches of rain and 7.3 inches of snow. The greatest amount of rain in any one day was 0.33 inches on the 4th-5th. At the end of the month there was no snow. The prevailing direction of the wind was northwest, and the total movement, 7,502 miles; average hourly velocity, 11.2 miles; maximum velocity for 5 minutes, 48 miles from the west on the 2nd. There were 8 clear days, 8 partly cloudy, 12 cloudy and 10 rainy.

CORRESPONDENCE

Drawing Heat From Nature

Editor of THE HEATING AND VENTILATING MAGAZINE:

It was a somewhat interesting coincidence that, following President Gormly's opening address at the annual meeting of The Heating and Ventilating Engineers, on January 22 last. I should have read at the end of the session a paper in which I followed somewhat the same trend of thought that had been in Mr. Gormly's mind in writing his address. He invoked the forces of Nature for help to man in heating; while I drew attention to the fact that gravity, the great universally-distributed natural force, could be successfully invoked to help man in this respect. That such help can be successfully relied on to a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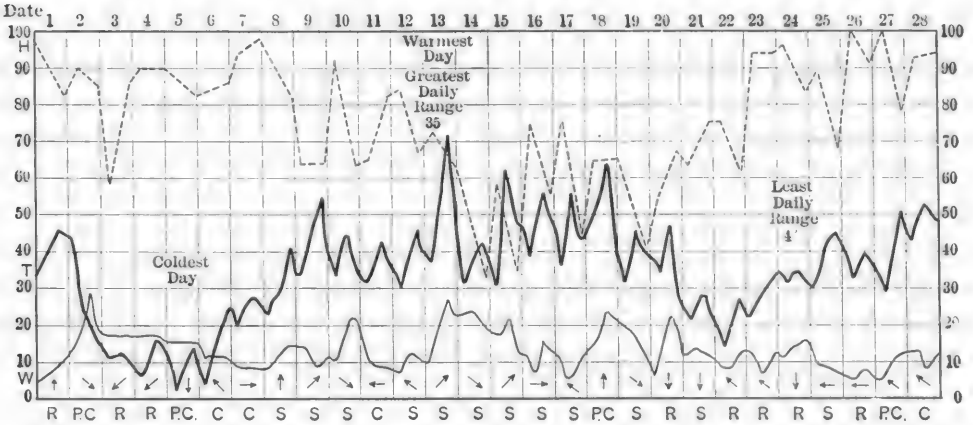
RECORD OF THE WEATHER IN NEW YORK CITY FOR FEBRUARY, 1907



RECORD OF THE WEATHER IN ST. LOUIS FOR FEBRUARY, 1907

Upper black line indicates temperature in degrees Fahr.
Dotted line indicates relative humidity in percentage
Lower black line indicates velocity of wind in miles per hour
Arrows fly with prevailing direction of wind.
S—Clear. PC—Partly Cloudy. C—Cloudy. R—Rain. Sn.—Snow

wonderful degree, is a conviction to which I have only just fully arrived; though I have been especially interested in this line of study for some years past. I am inclined to think that my perceptions in this connection will be regarded, in the future, as one of the great inventions of man; though I claim no special merit in having been the agent for arriving at this perception; for it has been one of the results of chance, rather than of intention on my part. I have not as yet gone far enough in my experimental work to be entirely certain as to just how great an advance can be made in the economics and healthfulness of heating and ventilation in their practical application; but I am convinced that such advance will be very astonishing, and that, in some cases, fully three-quarters of the fuel cost in heating can be avoided.

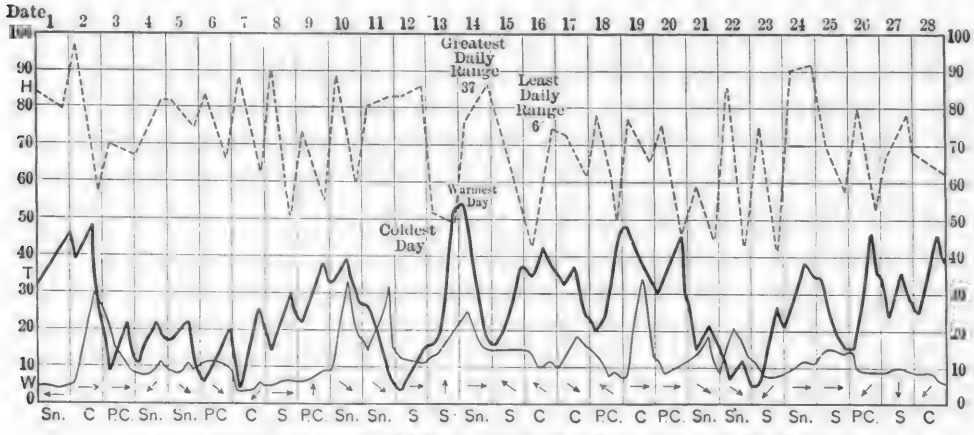
THE CAUSE OF THE SUN'S HEAT

With our finite powers of perception we of course cannot even surmise the ultimate source or reason of cosmic force and energy. We form our deductions from our senses of sight, etc.; but can make no deductions without evidence. Our almost entire source of heat on this earth is the energy that is delivered to us from the sun. The heat we enjoy that comes from the internal heat of our cooling planet is considerable, but is small in amount compared to that which comes from the sun. The cause of the sun's heat is now quite generally conceded by scientists to be due to the impact of cosmic matter which has been and is continually falling into the sun through the attractive force of the sun's gravity.

We would hardly care to have our houses heated by the impact of meteorites falling to earth through, or even very near, our houses; but we can utilize this same force of gravity in conserving and applying the sun's heat to a very much more extended degree than has previously been effected.

THE GROWING USE OF ALCOHOL AS A FUEL

To my mind, the most interesting line of work in this connection is in the line of conserving the sun's energy in the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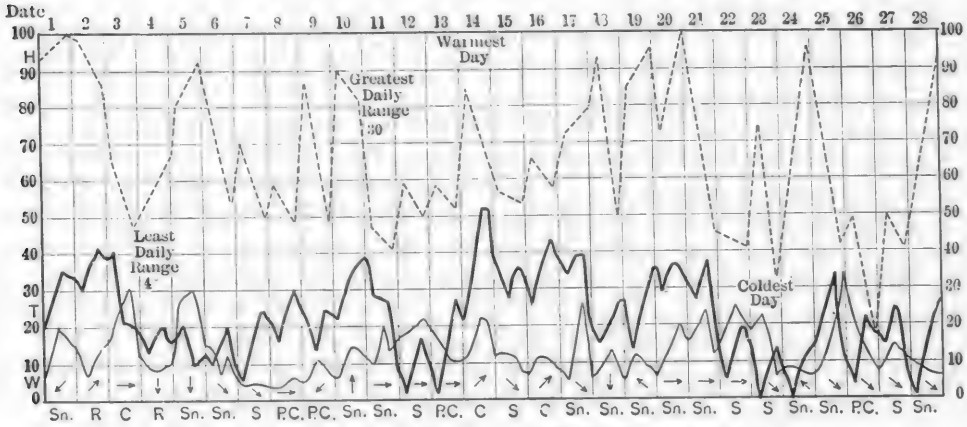
RECORD OF THE WEATHER IN PITTSBURG FOR FEBRUARY, 1907


Date
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RECORD OF THE WEATHER IN BOSTON FOR FEBRUARY, 1907

Upper black line indicates temperature in degrees Fahr.
Dotted line indicates relative humidity in percentage
Lower black line indicates velocity of wind in miles per hour
Arrows fly with prevailing direction of wind
S—Clear. PC—Partly Cloudy. C—Cloudy. R.—Rain. Sn.—Snow

growing of alcohol-producing crops. Practical methods for making very cheap alcohol from crops like sorghum are now in sight; and with cheap alcohol available, we have a convenient source of a means for heating and power production of practically unending extent. But we must not overlook the fact that we will have, for ages to come, the advantages of the presence on our earth of immense coal deposits, and that in this material there is the greatest possible concentration of the stored energy of the sun. We must also not overlook the fact that hitherto our use of this convenient source of heat and power has been one of unintelligent and reckless extravagance.

WASTES IN THE USE OF COAL

It is not complimentary to the intelligence of man that such tremendous economic wastes in the use of coal have been and are still practiced. Not much more than 5 per cent. of the heat units of coal is applied in actual work in electric lighting. About 10 per cent. is applied in locomotive work. From 12 to 20 per cent. is applied in power production. Between 25 and 30 per cent. is applied in the best explosive engine practice; and it is questionable if, on an average, more than one-third of the fuel value of coal gets into actual heating. There is practically no regenerative conservation practiced in heating; though a first step has been taken in re-using heated air in hot air systems.

EFFECT OF THE POSITION OF A BOILER UPON ITS EFFICIENCY

As one instance of how a very simple change in practice can effect unlooked-for results, let me cite: If a horizontal tubular boiler has a certain rating when fired in its normal position, and if it is stood on end and fired from below upward, that rating will be diminished; but if that same boiler is fired by introducing the heating gases at a high level of the boiler and the gases are drawn from a high level to a low level, and if cold feed water be introduced at the lowest level of a boiler and is progressively heated in its travel to the highest level, the rating of that boiler will be largely increased; and this result will be apparent even without any improvement in combustion.

This instance is only one way of many in which the natural force of gravity is able to help us. If in addition to this we apply this force intelligently to the furnace end of a heating apparatus, we can use fuel of nearly one-half the cost of that which is generally used; we can improve combustion from 5 to 25 per cent., and we can secure an equality of the rate of combustion in heating devices that is not thought of in the common practice of the day.

Yes, there are great possibilities in the future; but they are along the line of very simple applications of intelligent purpose. Heat has been drawn from natural sources, and it is already stored for our use in the coal fields. We can also draw unlimited stores of heat from the forces of Nature in the future by intelligent effort. We can even harness the wind and tides in our aid. But we should always remember that we must in every case, give a fair equivalent for what we get. Natural force changes its manifestation, but there is always an equable balance in the transmutating process. Something never comes out of nothing. But there are ways of getting what we want and need in the way of heat for a very much lesser cost than that we have been accustomed to pay. One of the greatest helps to us will be applied electrical transmission. But the greatest help of all will be in applications of that force of gravity which exerts so widespread an influence in every action of our lives. We must intelligently invoke that force to secure its aid.

With the editor's permission, I will, in a later communication, point out some of the more important causes of economic waste in heating processes.

DR. J. M. W. KITCHEN.

Orange, N. J., March 1, 1907.

American Foundrymen's Association

A movement is on foot, on the part of a number of American and Canadian foundrymen, to present to Dr. R. G. Moldenke, secretary of the American Foundrymen's Association, a testimonial in recognition of his successful efforts in the advancement of foundry practice during his tenure of office. It is planned to make the presentation at the next convention of the association, to be held in Philadelphia in May next.

New Firms

The Folsom-Webster Co., Inc., Pittsburgh, Pa., is a new firm merged from the firm of J. H. Folsom & Company and Frederick Webster Company. Business will be carried on at the address of J. H. Folsom & Company, 424 Fourth avenue, and a branch at New Brighton, Pa., will be opened. G. A. Grose will be the outside foreman.

Day & Kennedy Co., New Haven, Conn., is a new firm organized by W. A. Day and J. P. Kennedy, which will carry on a heating, general plumbing, gas fitting and sheet metal business.

Mohawk Valley Heating Co., Utica, N. Y., is a new firm which will supply heating apparatus. President, Clarence M. Lyman; vice-president, John W. Vogel; secretary, Russell Wheeler.

TRADE AND MISCELLANEOUS NOTES

Deaths

Dr. Adolf Wolpert died on January 9 last in Charlottenburg, Germany. Dr. Wolpert wrote the "Theorie und Praxis der Ventilation und Heizung."

Thomas Maddock, president of John Maddock & Sons, Trenton, N. J., died at Redlands, Cal., January 10.

Miscellaneous Notes

James A. Donnelly, New York, has been elected secretary of the Modern Science Club of Brooklyn.

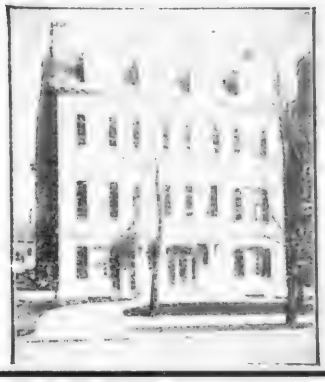
The Eastern Supply Association held its meeting in New York on Wednesday, February 13, when it was decided that a joint meeting with the Central Supply Association be arranged for at the Jamestown Exposition, June 19. The following resolution was adopted:

"Resolved, That no member of this association shall accept any order for material with the following or any other condition: This order is given on condition that the firm supplying the goods will pay for replacing any part that, when tested, is found defective."

Robert K. Story, general manager of the Central Radiator Company, Lansdale, Pa., announces his retirement from the firm, his resignation taking effect March 1. Mr. Story has been engaged during the past five years in building and equipping the plant of the Central Radiator Company and expects to enjoy a short period of long-needed rest.

Cuyler K. Sanborn, formerly vice-president of the Haydenville Company, Haydenville, Mass., has been elected vice-president of the Plumbers' Trade Journal Publishing Company, New York.

Sutcliffe Ventilating and Drying Co., Ltd., Manchester, England, advises us



ONE OF THE 30,000 HOMES
HEATED AND VENTILATED BY THE
KELSEY
WARM AIR GENERATOR
SYSTEM
SEND FOR BOOKLET 20 AND FOR 112-PAGE BOOK, "OPINIONS"
so that you may know why the Kelsey System is being specified for the finest class of residences, churches and schools in preference to any other system.
KELSEY HEATING COMPANY
307 Fayette St., Syracuse, N. Y. New York Office, 156 Fifth Ave.

The Albany Return Steam Traps
have been the STANDARD for over THIRTY-TWO YEARS. For returning water under pressure to the boiler, they will perform this duty fully as well, and in many cases better than the so-called steam loop.
Send for circulars A, B, C and D.
MANUFACTURED BY
ALBANY STEAM TRAP CO., ALBANY, N.Y.
FREDERICK TOWNSEND, PRESIDENT
JAMES H. BLESSING, GEN. MGR

that the motor and cycle trades in England are exceedingly busy and in many of the new buildings that are being built this company is installing interesting heating and ventilating plants. Among these plants is one for the Enfield Cycle Company's new works at Redditch, which has a floor area of 105,000 square feet; also the extension to the Eadie Company's works at Redditch, measuring 260 by 60 feet and three stories high. This firm has also the contract for the Abingden-Ecco new works at Tyseley, near Birmingham, where it is intended to build and equip the factory in three months' time.

Wm. M. Mackay, secretary of the American Society of Heating and Ventilating Engineers, has accepted the management of the Mackay Manufacturing Company (of which he has been treasurer for the past fifteen years) and has opened offices and showrooms at 113 Beekman street, New York. In addition to a line of brass goods, radiators, and heating supplies, the Mackay Manufacturing Company will handle an improved construction of sectional and round heating boilers. Having designed, patented and marketed many of the leading constructions of heating boilers placed on the market during the past thirty-seven years, Mr. Mackay's judgment will be considered and accepted by his host of friends in the heating business throughout this and foreign countries, and we feel, as in the past, that anything that he undertakes will prove successful in every way.

Chances for Business

Washington, D. C. —Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, until 3 P. M., April 11, 1907, for the construction, complete, of the extension to the U. S. Post Office and Court House at Asheville, N. C.

Washington, D. C.—Sealed proposals will be received at the office of the Supervising Architects, Treasury Department, until 3 o'clock P. M., April 9, 1907, for the construction, including heating apparatus, electric conduits and wiring, of the U. S. Post Office at Little Falls, N. Y.

Cleveland, Ohio.—A new hotel, containing 400 rooms, will be erected here. Plans are now being prepared by the architects which provide for the Standard Sanitary Mfg. Company fixtures. There will be 400 baths, 450 water closets and 450 lavatories.

Oakland, Cal.—The Oakland Hotel Company has advertised for bids for the clearing away of the buildings now on the site where the company will build its $1,500,000 hotel.

Business Changes

Meagher Heating Co., Pittsburgh, Pa., has been succeeded by the Burns & Fleming Company, which will carry on the business at the same address.

Manufacturers' Notes

H. W. Johns-Manville Co., New York, announces the removal of its Boston branch from 77-79 Pearl street to 55, 57 and 59 High street.

Haydenville Company, Haydenville, Mass., announces the following officers and directors elected at its annual meeting, held February 13, 1907, in Jersey City, N. J.: President, C. J. Hills; vice-president and treasurer, A. S. Hills; secretary, R. B. Hills; Hon. Richard W. Irwin, Northampton, Mass., and George L. Dayton, Jersey City. R. B. Hills, formerly manager of the Boston branch of the Crane Company, will take charge of the New York office of the company, in place of C. K. Sanborn.

Warren Webster & Co., Camden, N. J., announce that Mr. Charles A. Ball has become associated with them and that they have purchased the several patents on vacuum heating specialties invented

THE SCHOOL HOUSE, ITS HEATING AND VENTILATION

By JOSEPH A. MOORE, *Inspector of Public Buildings, State of Massachusetts*

The author having been for the last eighteen years engaged in the inspection of public buildings in Massachusetts, and in supervising the construction of and testing the various methods of heating and ventilation, especially in school houses, presents to those interested in our public schools some suggestions as to the construction and the heating and ventilation of such buildings. The class of buildings selected are those of small or moderate size, of which many are erected each year.

The author does not attempt to give theoretical or scientific descriptions or arguments, but simply such methods and plans as have been proved by actual experience to give satisfactory results.

Many of the plans were designed by the author for the annual official reports of the late Rufus R. Wade, chief of the Massachusetts district police.

The method of setting up indirect radiators, as shown in the plans and now generally adopted in Massachusetts, was designed by Mr. Moore, and first published in drawings which formed part of the official exhibit of the inspection department of the Massachusetts district police at the Columbian Exposition at Chicago in 1893, and for which an award was given.

Other plans formed part of the exhibit at the Paris Exposition in 1900, for which an award was also given, and at the Louisiana Purchase Exposition at St. Louis. **204 pages, illustrated. Price, $2.00**

Address **The Heating and Ventilating Magazine,** 1123 Broadway, New York

by Mr. Ball. Mr. Ball is well known to the heating trade and his knowledge of the field may be expected to strengthen the already well-organized staff of Warren Webster & Company's engineering corps.

Utica Heater Company, Utica, N. Y., announces the following changes in its officers as the result of its annual election, held February 4: President, John B. Jones; vice-president, W. C. J. Doolittle; second vice-president, John Toole; secretary, C. E. Hodges; treasurer, Edward Norris. The other directors elected are: George C. Hodges, A. B. Maynard and J. DeP. Lynch. M. D. Waldron was re-appointed superintendent. A notable extension of the company's business is being arranged.

Whitlock Coil Pipe Co., Hartford, Conn., has increased its capital from $200,000 to $400,000.

D. T. Williams Valve Co., Cincinnati, Ohio, has secured, as its eastern sales agent, Mr. Charles K. Thomas, formerly with the Lunkenheimer Company.

Iowa Radiator Co., Cedar Rapids, Ia., is building a foundry 80x128 feet, a machine shop, 50x96 feet and would be pleased to receive catalogues of machines and foundry supplies from manufacturers and dealers. The officers of the company are: E. L. Stock, president and general manager; C. H. Chandler, treasurer; W. H. Dunshee, secretary; A. J. Conley, vice-president and general superintendent.

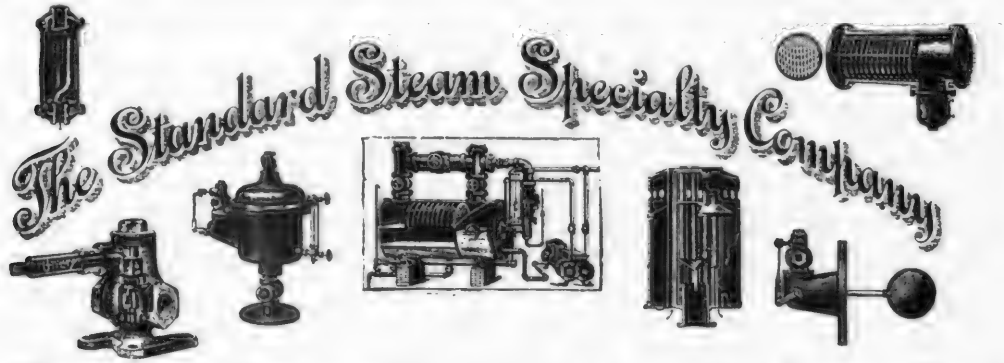
New York Blower Co., Bucyrus, Ohio, has arranged for the engine, generator and part of the boiler equipment for its new plant. Later, it may be in the market for a 70 H. P. return tubular boiler, feed water heater and boiler feed pump.

Early History of Steam Fitting Business in America

In a reminiscent article, appearing in the *Pierce Herald* for January, 1907, issued by the Pierce, Butler & Pierce Manufacturing Company, the following account is given of the early history of the steamfitting business in this country, which is represented by more than 14,000 contracting establishments at the present time:

The first "shop" in America was established by Walworth & Nason, at 36 Ann Street, New York, in 1841. Mr. Walworth had been engaged in the hardware business for several years before becoming allied with Mr. Nason, a brother-in-law, and an American who was then associated with J. Perkins & Company, of London, makers of the "Perkins System" of high-pressure hot-water apparatus.

These men introduced the use of 1-inch and ¾-inch pipe in steam heating. Mr.



UTILITY Exhaust Muffler, Oil Separator, Return Tank Pump Governor and Feed Water Heater

UTILITY Vertical Steam Receiver and Separator

UTILITY Pump Governor Valve and Head

UTILITY Pump Governor Valve

UTILITY Steam Separator

UTILITY Pump Governor

UTILITY Exhaust Head

Specify **Utility** Specialties in your work and we will guarantee their value in use.

Send for Catalogue H

542-544 WEST BROADWAY, NEW YORK

Nason is also responsible for the Globe valve, branch tee and many other devices which we use every day without thinking of the ingenuity and mechanical conception of the originator.

Up to 1849 nearly all the pipe and supplies were imported. It was the establishment of a tube mill by Walworth & Nason that gave the first impetus to the heating industry in America, for (although this same tube company, insufficiently capitalized, drove Walworth & Nason into bankruptcy in the hard times of 1851 and 1852) they had established a new industry in America that found efficient promoters all over the country.

As early as in 1839, two years before the beginning made by Walworth & Nason, S. P. Pierce opened a hardware and crockery store in Syracuse, N. Y. A large assortment of gas fixtures were put in stock, and gas lighting was introduced into Syracuse for the first time. At that time no heating supplies, such as we know to-day, were ever dreamed of, but, with this stock of specialties, a beginning was made, so that by the time Walworth & Nason's tube plant and heating apparatus came into prominence in the '50s, S. P. Pierce & Sons were doing pioneer work in what scanty supplies were needed through Central New York and the Western States of Ohio, Indiana and Michigan, along the line of the canal and the Great Lakes.

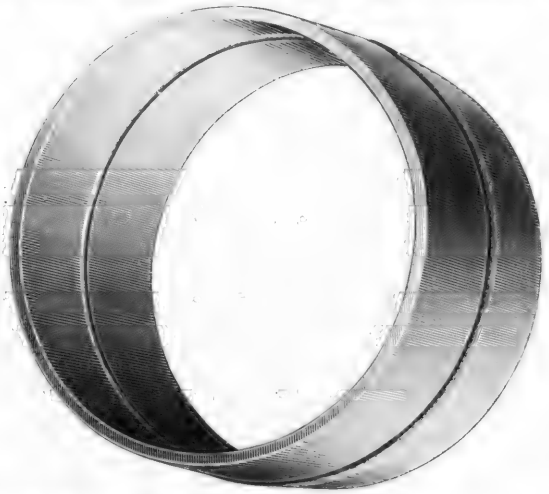
One of the sons graduated from Cornell University in 1873, where he had pursued the scientific course then offered. After an extended trip through Europe, where he was a close observer of everything pertaining to his father's business, he advocated more activity along heating and sanitary lines. In 1876 he formed a partnership with his father and brother-in-law under the name of Pierce, Butler & Pierce, doing a general wholesale business in gas, water and steam supplies, devoting particular attention to steam and sanitary engineering.

The foresight shown by this man, William K. Pierce, is evidenced by his early recognition of the growing demand for steam heat in private buildings and residences. He seemed enthused with the idea, and the many installations of the "Florida" boiler established the fame of Pierce, Butler & Pierce as steam and sanitary engineers throughout the Middle West; while such sanitary installations as they made in the new State Capitol at Albany, in 1885, gave them prestige all over the country.

In 1886 the heating business had grown to such proportions that the Pierce, Butler & Pierce Manufacturing Company was incorporated, with a capital stock of $200 000. A year or two later a large foundry and machine shop in Geneva, N. Y., were purchased and continued under

Zinc-Coated Steel Slip Nipples

For Steam and Hot Water Radiators and House Heating Boilers



THE PRATT CHUCK CO., Frankfort, N.Y.

FREE SAMPLES furnished to interested parties

the name of The Catchpole Manufacturing Company.

The two plants were combined in 1890, and a permanent site established between the Central and West Shore railroads at Eastwood, just outside of Syracuse. The plant was one of the largest of its kind in operation.

Again, a few years later, the formation of the American Boiler Company, with William K. Pierce as president, gave the heating industry greater impetus. When the patterns and interests of the consolidated companies were bought up by Mr. Pierce in 1896, and added to the plant at Syracuse, it became one of the largest of its kind in the world.

New Incorporations

Smoke Consumer Heating Co., Des Moines, Ia., has been incorporated with a capital of $75,000. The officers of the firm are: W. N. Simons, president; Enos Stanley, vice-president; L. Stanley, secretary; George Benedict, assistant secretary; Simon Casady, treasurer; directors, Enos Stanley, Dr. W. A. Guild and W. N. Simmons.

Warden King, Limited, Montreal, Que., has been incorporated with a capital of $1,000,000 to manufacture all kinds of heating supplies. The directors are: J. C. King, L. A. Payette, R. C. McMichael, W. Grieg and F. G. Bush.

National Radiator Co., Lebanon, Ind., has been incorporated with a capital of $30,000. The officers are: George W. Norwood, president; T. Holland, vice-president; W. J. DeVol, treasurer; W. S. Ritchie, secretary and general manager. The company is building a new plant, consisting of a foundry, 60x70 feet, a machine shop 30x60 feet and other buildings, all to be completed some time in April.

Peter Johnson & Co., Collinsville, Mo., has been incorporated with a capital of $5,000 to carry on a heating and plumbing business. The incorporators are: Peter Johnson, Mary Johnson and R. H. Richards.

Modern Plumbing & Heating Co., Seattle, Wash., has been incorporated with a capital of $10,000.

Twin City Plumbing & Heating Co., Webb City, Mo., has been incorporated with a capital of $5,000.

Hitchcock Bros. Co., Peoria, Ill., has been incorporated with a capital of $25,000 to carry on a heating and plumbing business. The incorporators are: William H. Hitchcock, Milton S. Hitchcock and Howard R. Horstman.

F. E. Manion & Co., Limited, New Orleans, La., has been incorporated with a capital of $10,000 to deal in plumbers' and steam fitters' supplies.

EMPIRE STATE ENGINEERING COMPANY ENGINEERS AND —MACHINISTS—

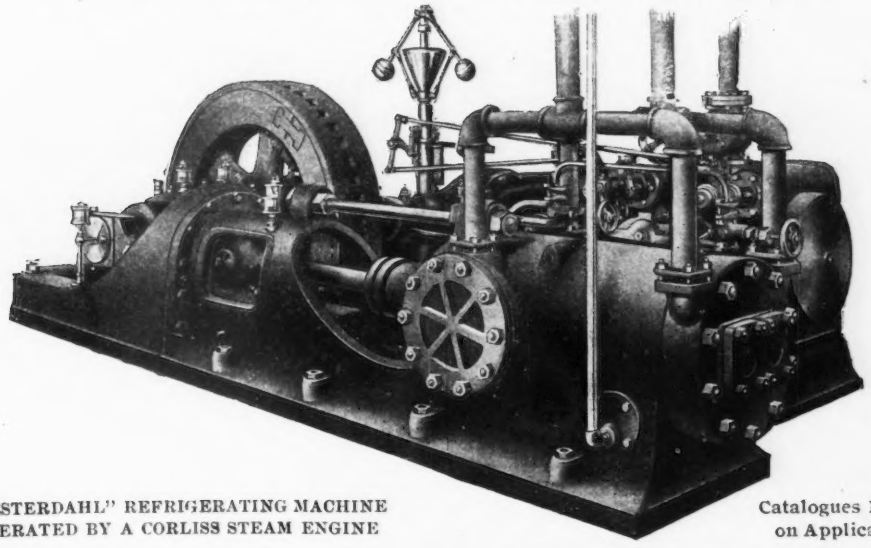
Builders of **ENGINES**

Ice and Refrigerating Machinery
Fans and Blowers

The Maxfield Steam Engine

For belting or direct connecting to dynamos, pumps, blowers, stokers, disc fans and general power 3 H. P. to 30 H. P. All speeds. Small space.

Dust proof, durable, simple, efficient.



"VESTERDAHL" REFRIGERATING MACHINE OPERATED BY A CORLISS STEAM ENGINE

Catalogues Mailed on Application

OFFICE AND WORKS: Foot of East 116th Street, NEW YORK

The King Radiator Co., Toronto, Canada, has been organized by Cluff Brothers, with a capital of $250,000. About $150,000 will be spent on the plant, which covers fourteen acres, in the next six months.

Staehle Plumbing & Heating Co., Newark, N. J., has been incorporated with a capital of $10,000. The incorporators are: Frederick F. Staehle, Eugene Lawson, Asa Sheppard and George D. Cook.

Washington Steam Heating Co., Seattle, Wash., has been incorporated with a capital of $10,000. The incorporators are: Thomas H. Lee, E. E. Hult and Reeves Aylmore.

Reliable Plumbing & Heating Co., Champaign, Ill., has been incorporated with a capital of $10,000, to carry on a heating, plumbing and lighting business. The incorporators are: Chester D. Brownell, Pearl Fisher and Earl C. Sabin.

Lionel C. Simpson Plumbing & Heating Co., Camden, N. J., has been incorporated with a capital of $100,000. The incorporators are: William Regan, Howard L. Miller and Francis D. Weaver.

J. D. Potter Plumbing & Heating Co., Denver, Col., has been incorporated with a capital of $50,000. The incorporators are: James D. Potter, Moses Stone, Jr., Salem J. Roseman, Arthur L. Moody and William H. Althouse.

Contracts Awarded.

Sodemann Heat & Power Co., St. Louis, Mo., heating and plumbing the Franklin Academy, at their bid of $6,797.

T. G. Scheid, Lima, Ohio, heating a new $30,000 library being erected here.

Greenwald & Lang, Toledo, Ohio, steam heating the $25,000 store and apartment building for the Ohio Savings Bank & Trust Company.

Sloan Heating Co., Pittsburg, Pa., heating the $15,000 residence being built in Oakland, Pittsburg.

Hoben & Doyle, Philadelphia, Pa., heating and plumbing the Evening Bulletin Building.

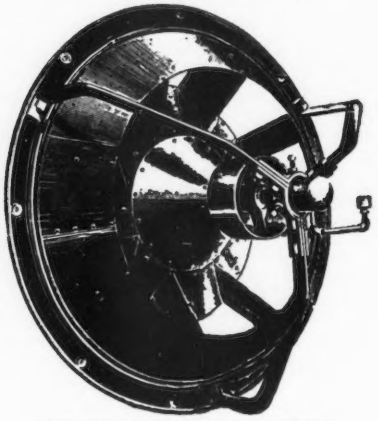
Spriggs Bros., Grand Forks, No. Dak.,

Post yourself on Vacuum Heating
MORCAN PATENTS
NEW LINE OF CATALOGUES WRITE AT ONCE FOR FULL PARTICULARS AND PRICES
CHICAGO MINNEAPOLIS
Kellogg Mackay-Cameron Co.
SOLE OWNERS
KANSAS CITY SEATTLE

ONE TYPE OF BLACKMAN.

PUSH OR PULL AIR

The Blackman and Duplex Cone Types


ONE TYPE OF DUPLEX CONE.

EXHAUST AND PRESSURE
WITH DIRECT CONNECTED ELECTRIC MOTORS OR STEAM ENGINES

FOR CATALOGUES, LIST OF USERS, SURVEYS AND ESTIMATES, ADDRESS

HOWARD & MORSE, 45 Fulton St., New York
MANUFACTURERS, ENGINEERS AND CONTRACTORS

heating, plumbing, and gas fitting the New Mann Building at Devil's Lake.

John T. Bealor & Co., Pittsburg, Pa., heating a large factory building being built on River avenue for the Western Electric Company.

Keeler & Co., Williamsport, Pa., steam heating a large business and office block at Lock Haven, Pa., for the Clinton Trust Company.

Bland & Lewin, Philadelphia, Pa., hot-water heating a residence in Oaklane.

John D. Roberts, St. Paul, Minn., heating the new Hackett, Walther, Gates Company Building.

F. X. Brunelle, Worcester, Mass., installing the heating system in the Swedish Gethsemane parsonage and a private residence on Lake avenue.

Butler Plumbing & Heating Co., Erie, Pa., heating and plumbing the large auditorium being built for St. Stanislaus' Polish Church.

A. Aschaffenburg, New Orleans, La., heating and plumbing the new Maison Blanche. The consideration is $90,000.

W. J. Harper, Wauseon, Ohio, heating the new K. of P. Building.

Metal Construction Co., Des Moines, Ia., steam heating, gas fitting and sheet metal work in the Fleming Block, which is to be built on Sixth and Walnut streets. The contract price is $63,000.

Edwin Hawes Company, Worcester, Mass., piping The Estabrook Building and the Fish Building.

Worth & Winterbottom, Falls City, Neb., heating the new Armour school in Armour, South Dakota, at their bid of $2,498.

General Fire Extinguisher Co., Providence, R. I., installing the heating system in the new brass foundry for the Kennedy Valve Manufacturing Company, Elmira, N. Y.

Shaw & Co., Minneapolis, Minn., heating the Minneapolis Brewing Company's works.

Van Sickle & Warren Co., Cleveland, Ohio, heating and ventilating a large addition being erected to the plant of the Cleveland Foundry Company.

Chafer & Becker Co., Cleveland, Ohio, heating the new plant of the Champion Rivet Company.

Blumve & Jay Co., Los Angeles, Cal., installing a vacuum steam-heating system in the ten-story office building at Fourth and Hill streets.

Stevick Heating & Plumbing Co., Freeport, Pa., installing the steam heating in a new distillery being erected here.

A Contrast.

"A French family can live well on what an American family throws away," is an old saying. And a great list of buildings equipped with the

WEBSTER SYSTEM OF STEAM CIRCULATION

are heated perfectly with steam that has little or no pressure left—the steam that with other heating systems is thrown away. "Dead steam is worth nothing," people say, "because without pressure we can't get it where we want it."

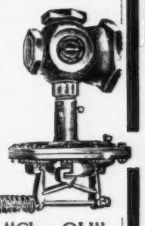
The WEBSTER SYSTEM can.

Write to-day for booklet 17-H.

WARREN WEBSTER & CO.
CAMDEN, N. J.

FOR low pressure delivery in steam heating a "Class Q" or "Class QH" Valve is specially adapted.

The "Class QH" Valve is specially intended for vacuum systems and has enlarged outlet connections to permit the use of a valve smaller than the delivery pipe.


"Class QH" Valve

"Class Q" Valve

Send for a Foster Catalog giving full details of these valves as well as Foster "Class W" Valves Free.

Exhaust Valves, Float Valves, Pump Governors, etc.

Foster Engineering Co.
Newark, N. J.

York Engineering Co., York, Pa., heating and ventilating the new jail, at their bid of $6,800.

Iron City Heating Co., Pittsburg, Pa., remodeling the heating system in the business building owned and occupied by the Guarantee Title & Trust Company.

Wyckoff, Lloyd & Co., Springfield, Mass., heating the addition to the Chipman Street School. The consideration is $8,584.

Columbus Heating & Ventilating Co., Columbus, Ohio, heating a new school building in Cameron, W. Va.

F. A. Clegg & Co., Louisville, Ky., installing the heating and power plant in the Victoria Hotel.

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Wanted first class outside superintendent, capable of handling all kinds of steam and water pipe work, capable of pushing his men; state experience and salary. Address Engineer, care of THE HEATING AND VENTILATING MAGAZINE, 1123 Broadway, New York.

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